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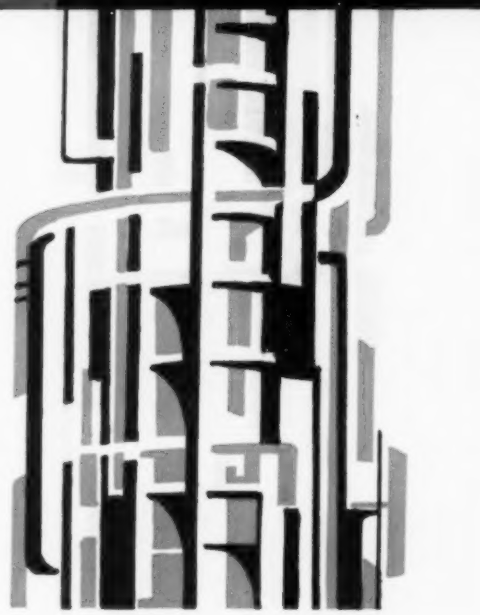
CHEMICAL ENGINEERING PROGRESS

JUNE 1958



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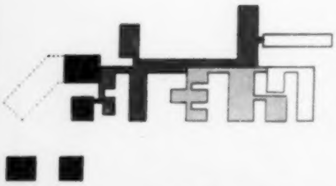

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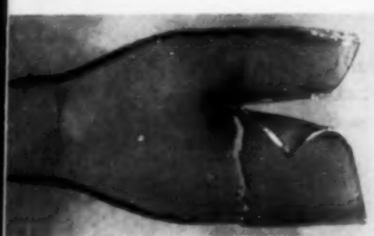

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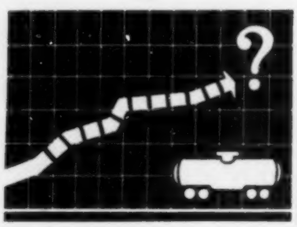

Projecting the profitability of new products is today more important than ever. Here is a more precise method, proved in use. Page 56

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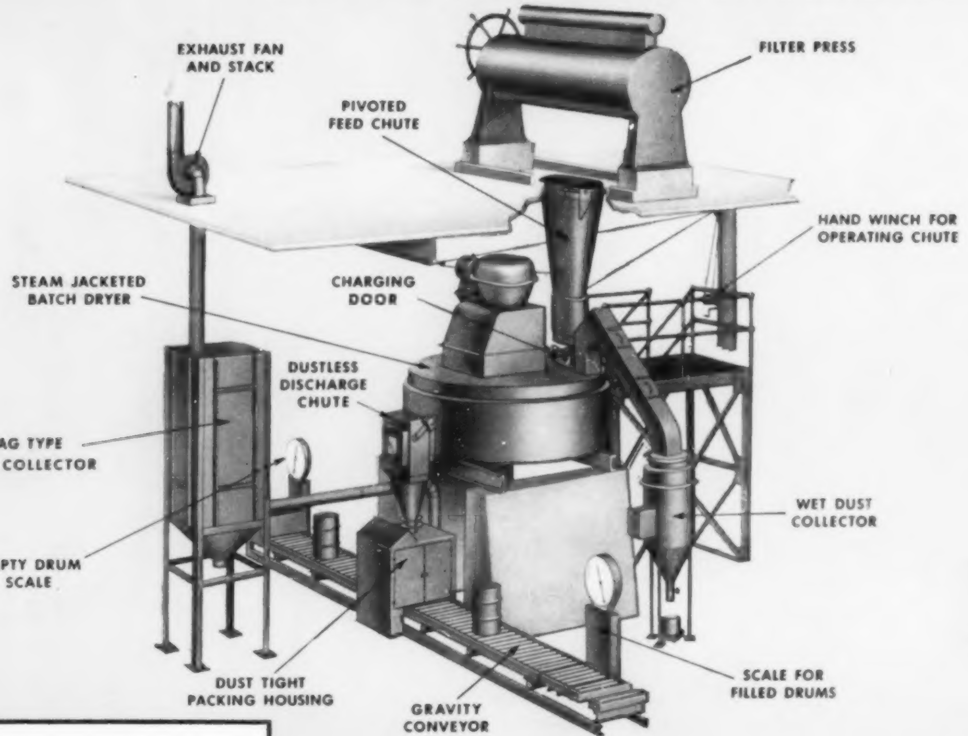

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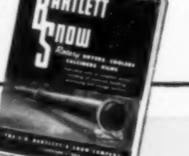

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CHEMICAL ENGINEERING PROGRESS
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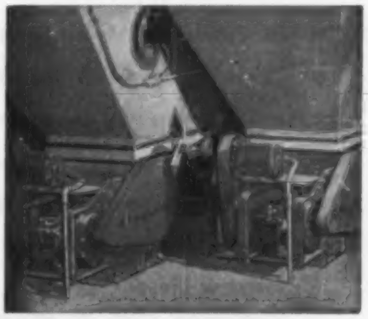

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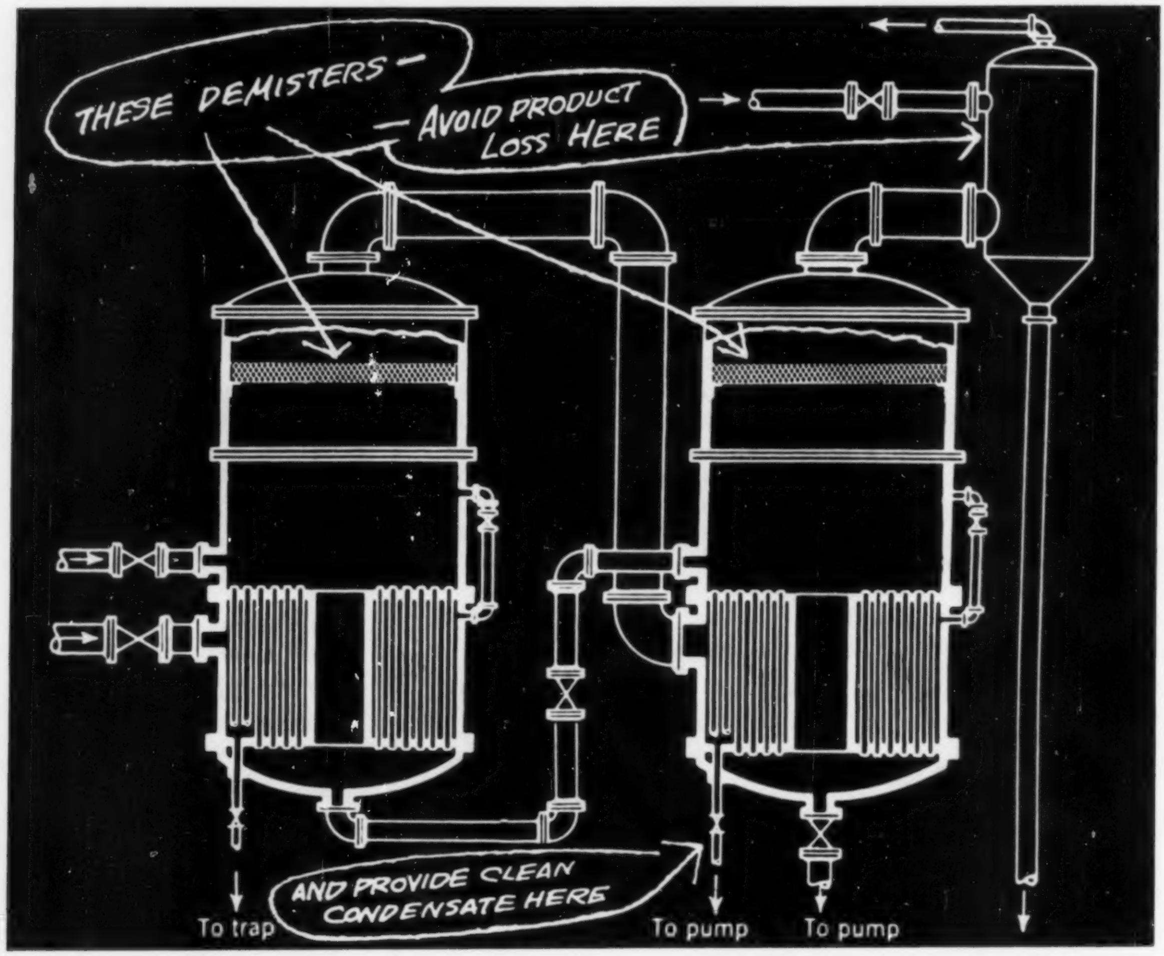

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Cover by Paul Arlt

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Abstracted from speech by J. B. O'Connor, president of Dresser Industries, Inc., in accepting degree from St. Bonaventure University.

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In the Du Pont Company, 88 per cent of the scientists are married and 73 per cent of their wives attended college. Although 15 per cent do not have children, the average number of children per family is slightly more than two, compared to one and one-half for the average American family.

In the matter of church affiliation, approximately 75 per cent mentioned church in listing their activities. In civic enterprises too, the study showed 37 per cent of the scientists were participants and 19 per cent held membership in community councils or associations. Also these scientists hold or have held 136 different kinds of positions of responsibility such as president, vice-president, board of governors, chairmen of committees, team captains, etc.

A detailed analysis of 600 of the questionnaires disclosed 47 of the group participate in politics; 51 in military organizations; 20 in dramatics; 76 in purely social organizations; and 112 in miscellaneous groups. In the fields of sports and of music scientists showed up very well.

Samuel Lenher

Abstracted from "The Scientist as a Person," a speech delivered at the Tenth Annual Management Conference.

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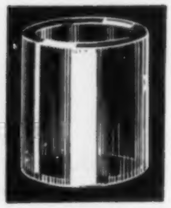

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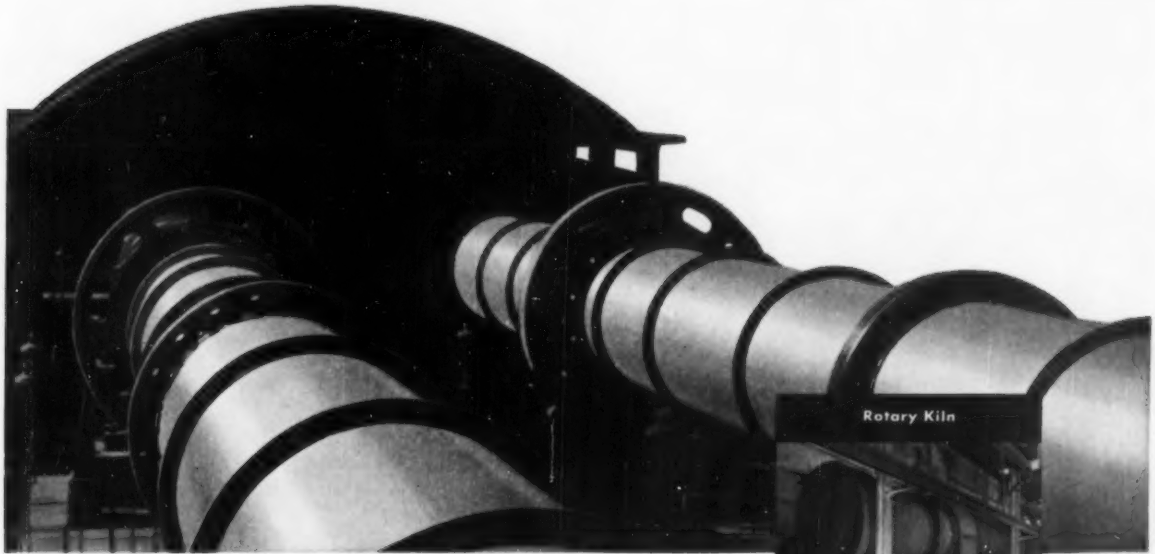

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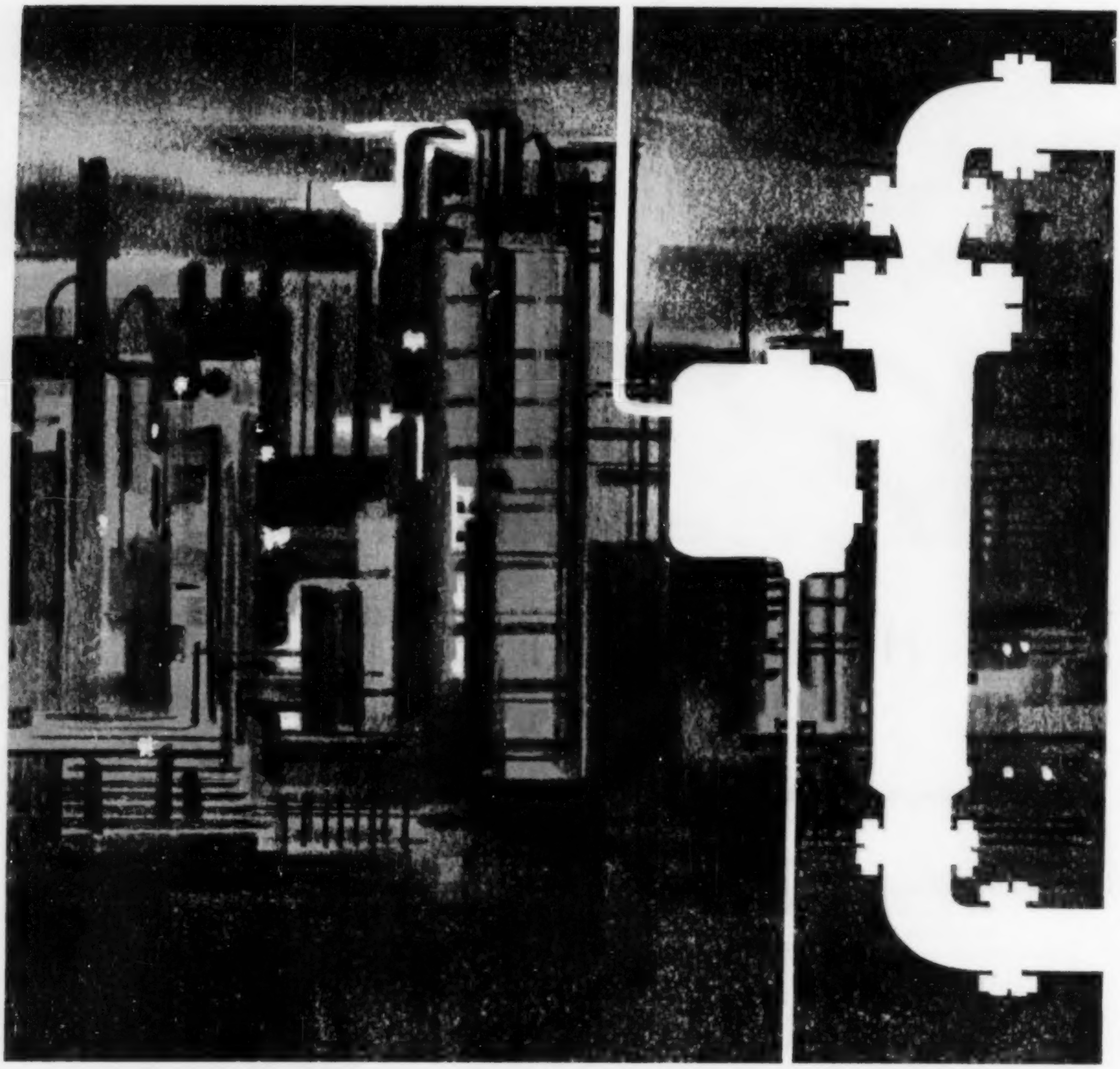

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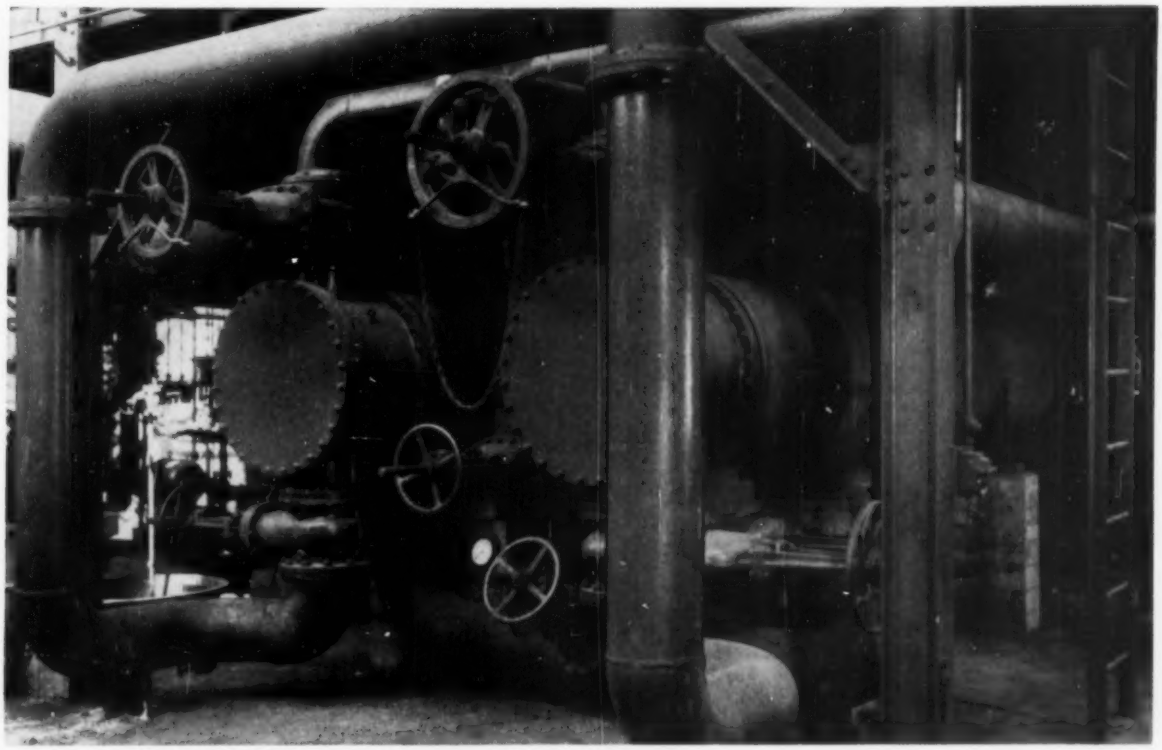

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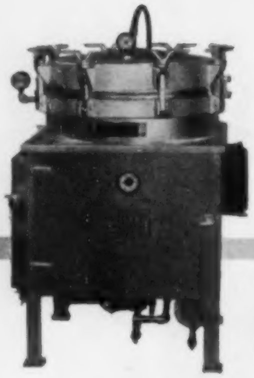

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marginal notes

Engineering materials

ENGINEERING MATERIALS HANDBOOK, Charles L. Mantell, Editor, McGraw-Hill Book Co., N. Y., 2,000 pages (1958), $21.50.

Here is a comprehensive reference book on engineering materials which should be on the shelf of every engineer concerned in any way with design of plants or processing equipment. The editor, Charles L. Mantell, chairman of the Department of Chemical Engineering at Newark College of Engineering, has assembled a staff of more than 150 authorities, each of whom has treated the area of his special competence. A good majority of the book's 43 sections will be of direct interest to the chemical engineer; certain are of course slanted more toward the electrical or mechanical engineer. In the chemical engineering field, particular mention must be made of the data on organic coatings, insulation, and gasket materials. Attention has also been concentrated on the newer and more unusual metals which are just coming into use for construction and equipment fabrication, and to materials used in the field of nuclear power. The last section, Sources of Information on Engineering Materials, is an exhaustive list of published material for the engineer who needs further data in a particular area.

Future oil and gas

THE FUTURE SUPPLY OF OIL AND GAS A STUDY OF THE AVAILABILITY OF CRUDE OIL, NATURAL GAS, AND NATURAL GAS LIQUIDS IN THE UNITED STATES IN THE PERIOD THROUGH 1975, Bruce C. Netschert, Johns Hopkins Press, Baltimore (1958), v-xi+134 p. $3.00.

Many facts are the characteristic mark of this work by Bruce Netschert, research associate in the energy and minerals area for Resources for the Future, Inc.

It was because of the persistent query on how nuclear power is likely to be integrated into the total supply of energy from various sources that the author undertook to study the matter from an analytical approach.

Arbitrarily taking the year 1975 as the terminal date, and also because he believes that it is the reference year most used in a discussion of the future of the crude oil and natural

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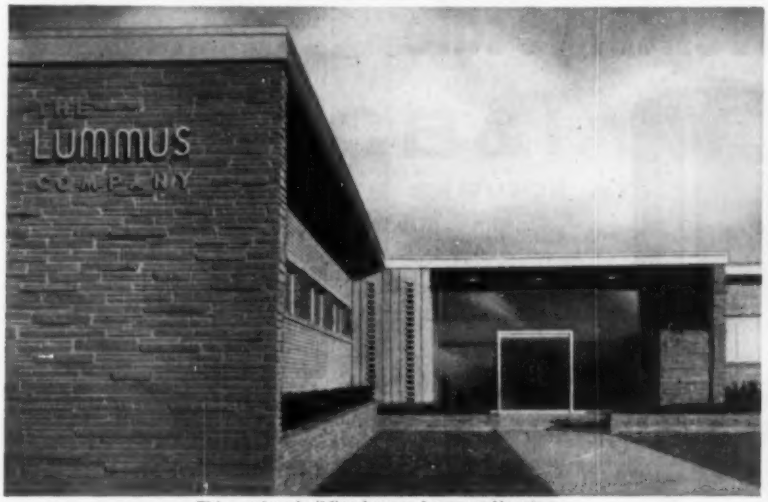

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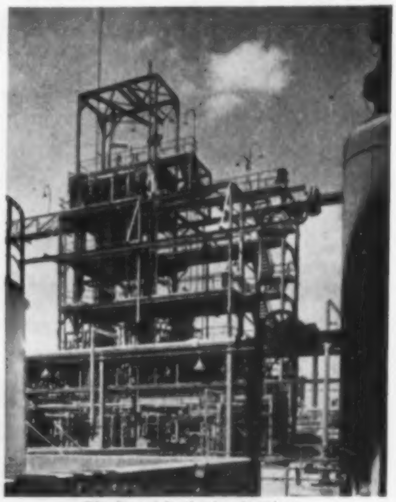

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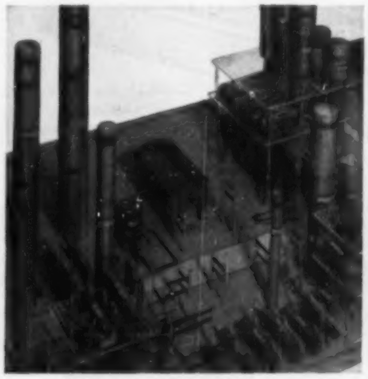

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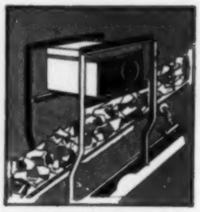
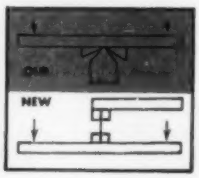


Recalibrates linearly with direct setting by just placing a known weight on the scale platform. The belt is not disturbed. No chains or involved calculations are necessary. Setting is positive, accurate, and long lasting.

Exclusive Thayer Plate Leverage System is guaranteed accurate for the life of the scale. There are no knife-edge pivots to wear down. Neither dust nor dirt nor vibration can affect its high accuracy. Thayer Scales are unsurpassed for simplicity and reliability under rugged conditions.



Write us about your bulk weighing problems for inventory or batching purposes.

THE Thayer SCALE

*THE THAYER SYSTEM OF PROCESS CONTROL BY WEIGHT

AUTOWEIGHTION

THAYER SCALE CORP., 13 Thayer Park, Pembroke, Mass.

marginal notes

from page 10

gas in this country, the author sets up a new concept or "resource base." He has narrowed his field of inquiry concentrating on the availability of energy sources and examining the variables —economic, technological, and geological—that determine trends in the fossil fuels. This should supply the needed perspective which is the purpose of the study.

The term "resource base" as used in this work includes the sum total of the crude oil, natural gas, and natural gas liquids present in the earth's crust in a given geographic area. His informative text is supplemented with tabular matter on the possible future capacity and/or production of the United States.

The first section on each of the hydrocarbon raw materials is concerned with an estimation of the natural stock in the United States. In the second section a similar listing and description are given of existing estimates of future capacity in the period through 1975. The third section examines the indicated future course of technology and its relation to future productive capacity. Finally the author takes up the subject of the possible role of alternative sources of supply: imports and synthetic equivalents.

Bonus: the story of shale oil as a source of gasoline and as a source of synthetic gas. H.R.C.

WASTE TREATMENT AND DISPOSAL ASPECTS TO DEVELOPMENT OF CALIFORNIA'S PULP AND PAPER RESOURCES —A COOPERATIVE STUDY, Publication No. 17, published by State Water Pollution Control Board, Sacramento, California, (1957), 102 p. $3.75

This report on a cooperative study made by many individuals and agencies is primarily a technical review and analysis of some of the major problems which will confront an expanding pulp industry in California. Here is a valuable compilation of available information pertinent to the pulp industry in northern California. Maps, graphs, and tabular matter supplement the text.

SUCCESSFUL PROCESS PLANT PRACTICES—OPERATION, MAINTENANCE, AND SAFETY, R. L. Davidson, McGraw-Hill Book Company, New York (1958), 302 p. $10.00

This is a how-to-do-it manual of process plant problems and how they are solved in actual practice.

CB&I TANKS

ON CORROSIVE SERVICE AT SOUTHERN NITROGEN

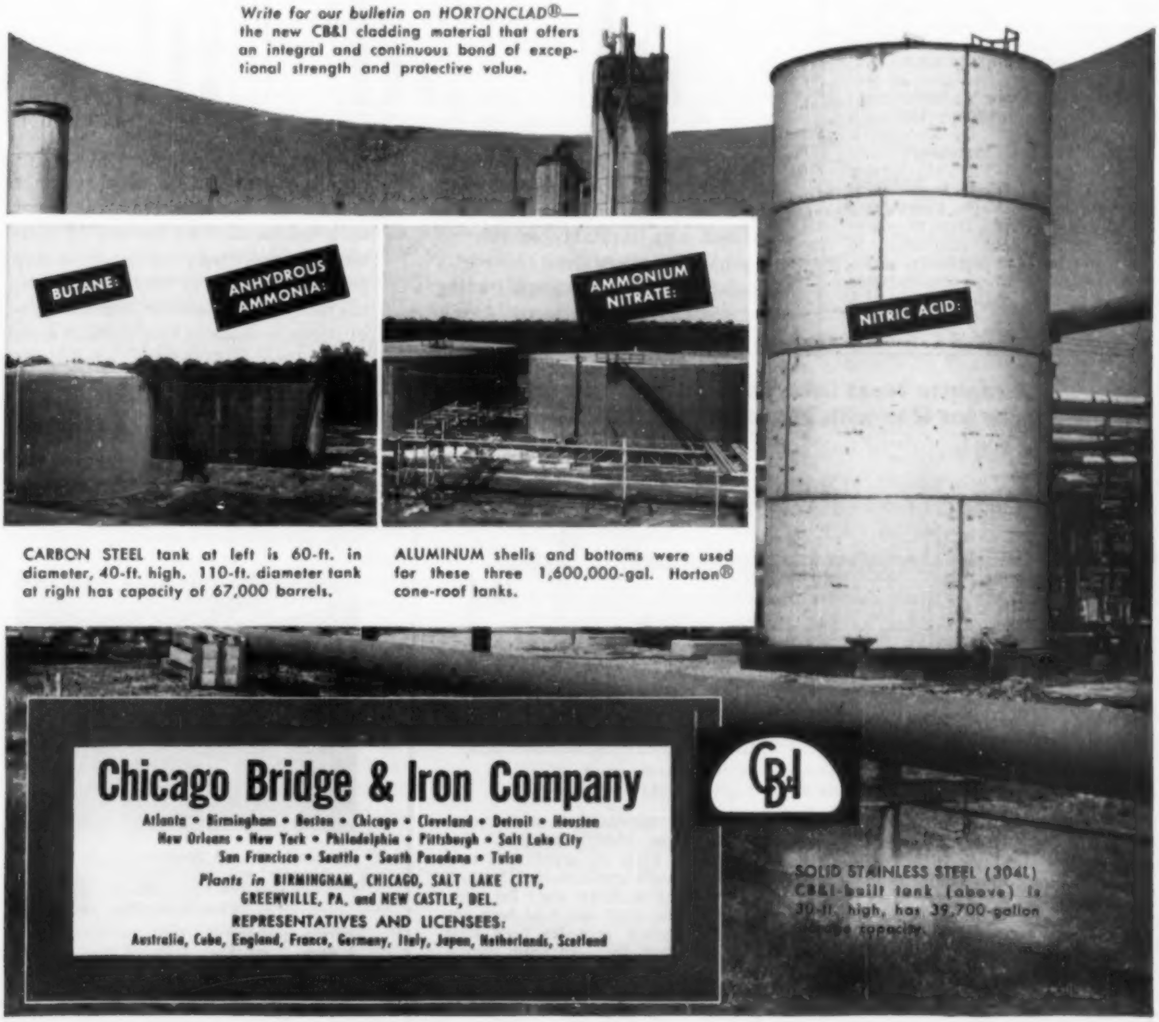
Special metals help prolong tank life at Southeast's first basic nitrogen plant.

Southern Nitrogen Company's $14,000,000 plant at Savannah, Georgia, is designed to provide southeastern states with a nearby, economical source for a full line of basic nitrogen products.

To insure maximum performance life for tanks used to store a variety of highly corrosive materials which are produced or handled in the plant processes, CB&I specialists worked closely with the Girdler Company (General Contractors) and Southern Nitrogen officials. Carbon steel, solid stainless steel, aluminum and other combinations of corrosion resistant metals and alloys were used.

The handling of special metals, including design of structure, fabrication and erection, is a specialty and an art with CB&I. As a result, the "little" engineering or structural refinements that mean a *lot* in overall plant performance—have become an integral part of any welded steel structure that is furnished by CB&I.

Write for our bulletin on HORTONCLAD®—the new CB&I cladding material that offers an integral and continuous bond of exceptional strength and protective value.



CARBON STEEL tank at left is 60-ft. in diameter, 40-ft. high. 110-ft. diameter tank at right has capacity of 67,000 barrels.

ALUMINUM shells and bottoms were used for these three 1,600,000-gal. Horton® cone-roof tanks.

SOLID STAINLESS STEEL (304L) CB&I-built tank (above) is 30-ft. high, has 39,700-gallon capacity.

News from

National Carbon Company

Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. In Canada: Union Carbide Canada Limited, Toronto

HEAT TRANSFER AUTHORITY CONSULTANT TO NATIONAL CARBON COMPANY

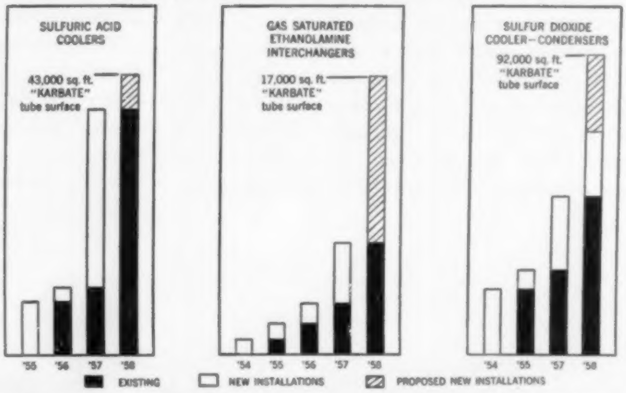
DR. DONALD Q. KERN

D. Q. Kern and Associates, specialists in thermal design of chemical process units, work with National Carbon Company in developing and applying "Karbate" impervious graphite heat transfer equipment.

Before establishing his own organization, which serves many U. S. and Canadian companies, Dr. Kern had a distinguished career in industry. Concurrently, from 1943 to 1953, he was professor of chemical engineering, The Graduate School, Polytechnic Institute of Brooklyn. Here he was in charge of advanced instruction in heat transfer and thermodynamics. He is also author of the text, Process Heat Transfer, now in its seventh printing.

"Karbate" Heat Exchangers prove economically superior in corrosive processes

Charts below show expanding use of "Karbate" impervious graphite in three typical corrosive services

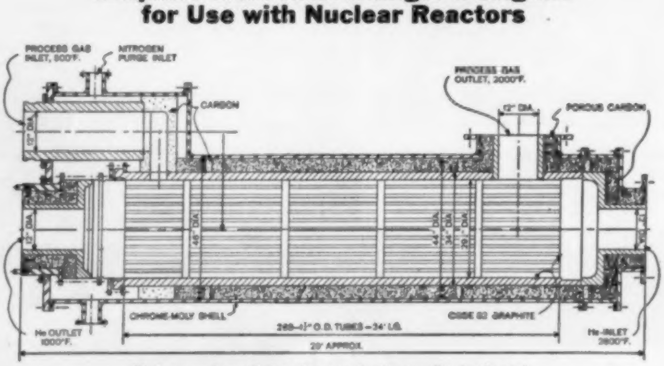


"Karbate" impervious graphite resists all concentrations of sulfuric acid up to 60% at temperatures to boiling. This combined with resistance to thermal shock makes "Karbate" heat exchangers logical choices for heating and cooling sulfuric acid.

Long life and moderate costs frequently make "Karbate" heat exchangers the preferred choice over metal units in ethanolamine service. In addition, the improved corrosion resistance permits operation at far higher velocities thus making possible several fold reductions in required heat transfer area.

The large surface areas required for cooling — condensing of wet sulphur dioxide containing gases are provided conveniently and economically by "Karbate" shell and tube heat exchangers such as shown below. The corrosive gas is handled on the tube side permitting easy access for cleaning.

Graphite Heat Interchanger Designed for Use with Nuclear Reactors



This gas phase interchanger is thermally designed to handle heat generated in a 5 megawatt reactor.

Interest increases in the use of nuclear generated heat for chemical processing applications. In such operations, a gas heat interchanger of the type shown would operate in a loop with the reactor. Hot helium gas from the reactor circulates through the tube side of the exchanger, while process gas to be heated passes through the shell side.

Because operating temperatures range from 2000° to 2500° F., "National" Code 82 graphite is well suited for such applications. This low permeability material used for constructing the shell and tube heat exchanger shown provides high heat transfer rates, freedom from corrosion and metallic contamination, and resistance to thermal shock.

"National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE

NATIONAL
TRADE-MARK

Many-Dimensional Tightrope for Petrochemicals

Now in sight is the end of the good old days for the petrochemical manufacturer. No more is his raw material almost a scavenger product. Now he has competition for his raw feed. How has he reacted?

First, he has worked hard to optimize his processes the Nth degree to live within the narrowing gap between what he has to pay for raw materials, plus his rapidly increasing construction and operating costs, and what the customer will pay him for the product—which latter bears no necessary relation to his costs. This has led to some mighty elaborate chemical engineering. There is, however, an end to this street.

Second, he has increased the complexity of many of his products, adding more value by manufacture, so that the increasing cost of feed will be proportionately less important.

As gasoline engines become more sophisticated, today's motor fuel manufacture requires extensive chemical recombinations similar to petrochemical operations. Fuels are now improved by chemical additives of various kinds; no simple set of specifications today can describe a good motor fuel. Motor fuel has become a competing outlet for petrochemical raw materials.

At the same time, dry gas has been in increasing demand for industrial and home use, with the result that distress sales of this once-surplus material are a thing of the past in most of North America. The petrochemical manufacturer, accordingly, sees many of the materials that gave him his start costing him steadily more.

In the early days of the petrochemical industry, by-products, such as gases from normal refinery operations, were utilized. Increased demand for the products led to complete utilization of these raw materials. Special plant and processes had then to be introduced to make the raw material for the petrochemical operations. The large capital investment required for plant specifically to produce these erstwhile raw materials makes it proper to give ethylene, propylene, butylene, etc., the status of "chemical intermediates", or even "chemicals", rather than raw materials.

The trend toward competition between the petroleum and petrochemical industries for intermediates is intensifying as petroleum refining seeks methods for keeping up with the advancing octane demand. At present, processes for converting petroleum hydrocarbons into high octane aromatics are very much to the fore, while at the same time petrochemical interest is directed to such things as cyclohexane and para-xylene for synthetic fiber manufacture.

The walking of this many-dimensional tightrope is the petrochemical business today. And there is no safety net underneath to catch the careless.

From an address by W. M. V. Ash, president, Shell Oil of Canada, delivered at A.I.Ch.E.-C.I.C. Conference, Montreal, April, 1958.

Federal Engineering Advisory Board?

James R. Killian, Jr., special advisor to the President on Science and Technology has stated that he will communicate with Representative J. W. McCormack with regard to the establishment of an Engineering Advisory Board to the Federal Government. The action follows a meeting between Killian and presidents G. E. Holbrook (A.I.Ch.E.), A. B. Kinzel (A.I.M.E.), and E. R. Needles (E.J.C.). First initiative in the matter came originally from Representative McCormack in a letter to the presidents of the Founder Societies (CEP, May, Scope, page 22).

Jubilee in Ohio

Governor C. Wm. O'Neill has proclaimed the week of June 22 as Chemical Engineers Week in Ohio, in honor of A.I.Ch.E's 50th Anniversary.

Shippingport Dedicated

Red Letter Day in the history of atomic power was May 26, when the Shippingport Atomic Power Station was officially dedicated.

From Here and There

A $3 million liquid oxygen, nitrogen, and argon plant near Philadelphia is under construction by Chemtron Corp. . . . Purchase of chemicals by U.S. railroads amounted to $47,279,000 in 1957. . . . Girdler has been awarded an Air Force subcontract for a hydrogen plant at the Olin Mathieson high-energy fuel plant at Niagara Falls, N. Y. . . . Japan Synthetic Rubber Co. will erect first synthetic rubber plant in the country a 45,000 ton/year GR-S unit at Yokkaichi. Investment: $30 million, contractors: Blaw-Knox. . . . Air Reduction will make polyvinyl alcohol resins in a new 20 million lb./year plant at Calvert City, Ky.

Soviet Bid for Chemical Plants Big Question

SCOPE

Who is going to build $100 million worth of chemical plants for the Soviet Union? This is the size of the present "shopping list" which the Soviets are dangling under the noses of American and European chemical and engineering companies. The Russian decision to seek help abroad seems to stem from recent approval by the Central Committee of the Communist party of a Krushchev-sponsored plan to spend some $25 billion by 1965 for chemical plant expansion and construction. This assumption accords well with recent Russian emphasis (at least in the press) on consumer goods. Synthetic fibers, plastics and resins are said to be major items in the proposed consumer goods expansion.

Not only have the Russians stated that they wish to buy whole plants, but also that they want to hire foreign technicians to assist in construction and start-up. The consideration by some American chemical engineering and construction firms, many of which are today on comparatively short rations, would seem likely.

Washington Reaction

Big question is, how do the Russians propose to pay? Best informed guess is that they will either try to arrange some sort of barter deal or that they will seek long-term credits; this supposition is based on the theory that the Russians do not have sufficient reserves of either foreign exchange or gold to pay cash on the barrelhead. Since it is evident that most American engineering firms would insist on immediate payment, certain circles in Washington are afraid that American know-how will be funneled to Russia through European engineering firms which may be willing to accept long-term payments, or some form of barter.

Big question remains, which side of whose bread is going to be bartered?

—J. L. Gillman Jr.

Pharmaceutical Companies Deny Collusion

A Federal Grand Jury in Trenton, N.J. has indicted five corporations on charges of violating the Sherman Anti-Trust Act in sale of polio vaccine to Federal, State, and local governments. Says Merck, one of the companies, "There is absolutely no substance to the charge against Merck. . . . These pricing decisions were made independently, in conformity with the law and the public interest." "This is complete nonsense", says a spokesman for Eli Lilly, which made over half the vaccine sold in the U.S., "It would be a strange conspiracy, indeed, that had as its purpose constant decreases in prices."

Cyanamid Continues Expansion Program

Overall capital expenditure for plant modernization and expansion will range from $50 to $75 million in 1958, says Cyanamid. Figure for 1957: $84 million.

Washington Gleanings

A House bill recently introduced calls for $75 million per year of Federal money to finance "Future Scientists of America" clubs. . . . AEC's 1959 program seems to be having a hard time getting off the ground—Joint Committee on Atomic Energy is said to be insisting on a long-range program that the Commission finds unpalatable. . . . No early action is seen on the proposed Science and Technology Bill aimed at creating a Department of Science and Technology. . . . Following a series of hearings before the House Subcommittee on Manpower Utilization, decision is that no arbitrary ceiling can be imposed on the cost of recruiting engineers for work on Government contracts. . . . No education bill is expected to pass this Session—grass roots sentiment, measured by Congressional mail, is said to be practically zero. *—J. L. Gillman, Jr.*

Spevak Case To Be Appealed to Supreme Court

Following denial of an appeal by the U. S. Circuit Court of Appeals, it is understood that the Spevak case will be appealed to the Supreme Court. Question at stake is whether an engineer may bar the AEC from disclosing previously secret data on heavy water processes until his patent and other rights are adequately protected (see Scope, CEP, February, 1958). Important factor in the earlier stages of the case was a "friend of the court" brief filed by EJC on behalf of Spevak, an A.I.Ch.E. member.

First Municipal Water Desalting Plant in U. S.

A 28,000 gal./day electric membrane unit will desalt brackish well water for drinking purposes in Coalinga, Calif., will replace 45-mile rail haul from nearest fresh water source. Expected savings: $400,000 in next ten years; equipment suppliers: Ionics, Inc.

Capital Equipment Rentals Up Over 1957

A 14% gain for the first four months of 1958 over 1957 is reported by U. S. Leasing Corp. Prominent items in rental upswing are said to be contact acid units, cracking plants, research and development plants leased to chemical, petroleum, rubber companies.

Chem Execs Plot Expansion, Weigh Basic Research

SCOPE

With the recession on the minds of many, the CMRA, meeting recently in New York, featured techniques for expansion in the chemical industry.

"Make foreign contacts a basic factor in your expansion program," was the advice of Scientific Design's Thomas Brown, V.P., in charge of sales and contracts. "When we have gone beyond our national boundries in our quest for know-how on new processes," said Brown, "we have widened our scope greatly. Different national economies generate different developments."

Another advantage in seeking know-how from a foreign country, continued Brown, stems from the fact that companies abroad are becoming increasingly interested in capital investment in the U.S., as their own internal markets approach saturation. A number of major chemical companies in Europe would be willing to supply a portion of the capital for a new venture in the U.S., or to accept a part equity in the venture in exchange for know-how.

Pros and cons of the projected European Common Market and its probable positive and negative effects on U.S. chemical industry were weighed by John Hilldring of General Aniline & Film.

Capital Conclave

In Washington, almost simultaneously with CMRA's New York gathering, another executive contingent attended a day-long National Science Foundation Conference on R&D and its impact on the economy, received what some felt was intended as an Administration shot-in-the-arm to stimulate business activity in fundamental research.

"There is widespread recognition," said Presidential Science and Technology Advisor James R. Killian, Jr., "that the economic pay-off of research is great, that it has created new products and expanded industry, that it has increased productivity and wages, and that it has introduced a new stabilizing influence in our economy."

"There still remains much to be understood," continued Killian, "about the role of research in our economy. Especially do we need more refined quantitative measures of the economic forces generated by research, of the relation between research and productivity, and the contribution of research to gross national product."

NSF's director Alan Waterman summed up the days work, stressing the essential unity of the various fields of knowledge and research. Said he, "The fundamental challenge to us, all of us, in thinking through and formulating a national science policy, is that no aspect of this unity should be slighted. The slighting of one sector is sure to create lags, unexplored areas, and hobbling effects . . ."

Reaction from the executive audience was mixed. Some felt that, while basic research is a worthy enterprise, the problem was coming up with enough profit-producing answers to make it pay off. Others thought that the agenda of the meeting had been somewhat too broad and general. Said Samuel Lenner, Du Pont V. P., for example, "It would seem to be well worth while considering another conference at a later date for those having more highly specialized research interests."

J. L. Gillman Jr.

Lindsay Chemical and American Potash Merge

Voted recently, a new merger will make Lindsay Chemical a division of American Potash. Special emphasis on boron products and alkali metals is expected to result from the combine.

Atomic Accident at Chalk River

Atomic Energy of Canada's Chalk River test reactor will be out of service for a month. No injuries to personnel were reported, but the building was contaminated by radioactive dust when a uranium fuel element disintegrated.

Arctic Mineral Exploitation Proposed in Canada

A program of research to assist in "opening up the mineral resources of our Arctic islands," has been proposed by Diefenbaker's new conservative government in Canada. Chief target of program will be vast mineral deposits at Pine Point on Great Slave Lake, now inaccessible for lack of transportation.

Big Titanium Tetrachloride Plant Leased

Stauffer Chemical's recently-completed 50 million lb./year titanium tetrachloride plant, Ashtabula, Ohio, has been leased to National Distillers, with option to buy. Following start-up, expected by this summer, the new unit will supply titanium tetrachloride to National Distillers' titanium sponge plant at Ashtabula, which was recently transferred to Mallory-Sharon Metals when National Distillers acquired a one-third interest in Mallory-Sharon.

Monomolecular Hexadecanol Proved Low-Cost Water Saver

Tested over several months in U. S. and Australia, hexadecanol films are said to have reduced evaporation from reservoirs by 50 to 60%. According to Victor La Mer of Columbia Univ., one pound of hexadecanol at about 40 cents will cover ten acres as a monolayer, monthly requirement under field conditions is about one pound per month per acre. Pioneer in the field was Nobel Prize winner Irving Langmuir.

EJC May Be EJC, Inc.

The right to incorporate has been granted to Engineers Joint Council by New York State. Reorganization awaits affirmative votes by two-thirds of EJC constituent member societies.

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

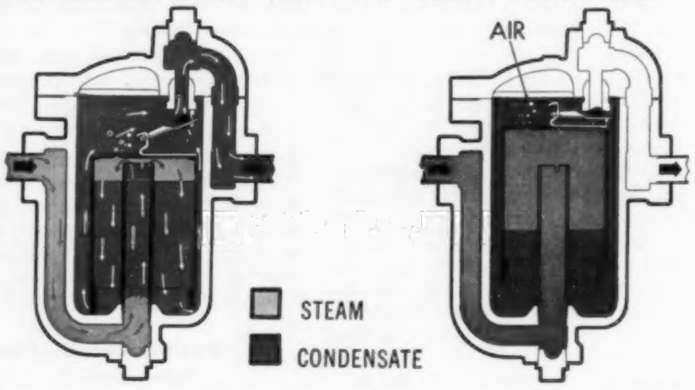
You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

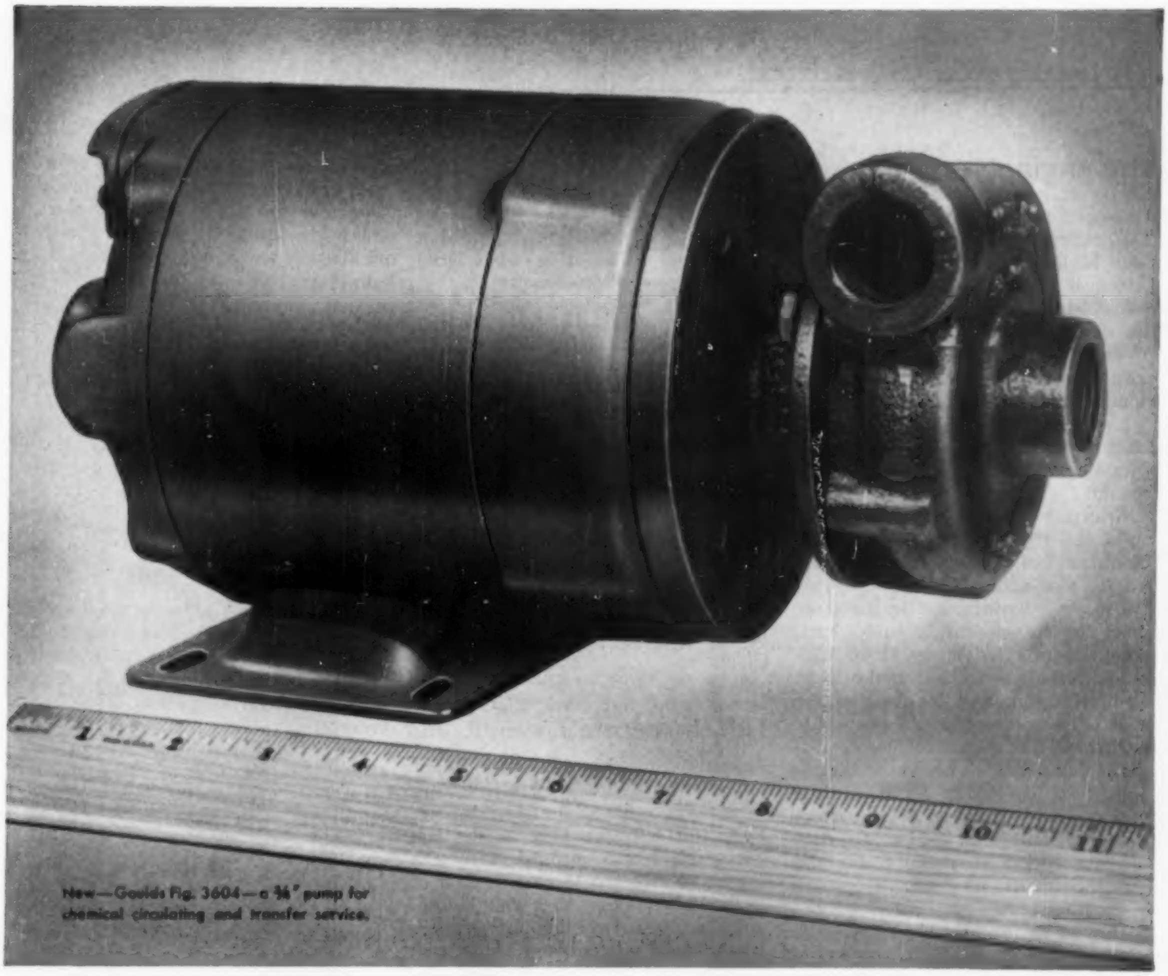
We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
9763 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



New—Goulds Fig. 3604—a ¾" pump for chemical circulating and transfer service.

Here's a small pump with big-pump stamina

Ideally suited for handling corrosive materials

Small, compact—this new pump fits in where space is a problem. But you can rely on it for continuous service round the clock, round the calendar.

It's available from stock in 316 Stainless Steel—which provides the widest and most economical coverage of liquids commonly handled by a pump of this type.

The mechanical seal—with carbon, Teflon, stainless steel and ceramic parts—is noncorrosive.

The impeller clearance is externally adjustable to compensate for wear.

The pump is small enough (10½ x 5½ x 5½) and light enough (23 lbs. with motor) for lab or pilot plant operations. It's designed for temperatures to 220° F. and working pressures to 75 p.s.i. Capacities to 16 GPM and heads to 28 ft.

For circulating duty, as a component in larger equipment, this new Goulds chemical pump offers advantages in size, weight, cost, and dependable performance.

Complete information on this high-quality pump—performance curves and specifications—is offered in Bulletin 624A4. You can get a copy from your Goulds representative, or by writing us.

GOULDS
PUMPS FOR CORROSIVES

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK
Main Office and Works

Branches and Representatives in all principal cities

The engineer as a community citizen

To support C.E.P.'s article by Governor McKeldin of Maryland on "The Chemical Engineer and Politics," I should like to apprise your readers of the steps taken or initiated, and the progress made, by one chemical engineer seeking a better and more efficient county government.

I was first concerned with the high taxes my neighbors and I were paying with seemingly little improvement or benefit. . . .

Realizing that alone I could do nothing, I interested the Junior Chamber of Commerce's Public Affairs Committee in helping. This fast-moving organization, in the short space of six months, aroused such public interest in county affairs that public forums were held in the Civic Center, cosponsored by most of the civic clubs in the county. A state-wide movement was started to sponsor legislation designed to overcome the inequalities in voting rights of the various county districts. Support from many organizations and a few state officials added strength, facts, and guidance to the program.

Programs were submitted to the Society of Professional Engineers seeking to enlist their aid in setting up standards of road and bridge building at the county level, and asking them to support the County Engineers' office.

No matter what the outcome, the associations developed, and the spirit engendered by actively advocating better government at the grass-roots level will benefit both the individual and the nation as a whole.

Below is an outline in part of the questions and procedures that can be effectively used by any civic-minded engineer who wishes to do his part in local politics:

1. What are the facts of present operations of county government?
   Are bids being asked for on all purchases over $1000?
   Are purchase orders issued so that money is always available to pay claims within discount period?
   Is competent expert advice available for road-building projects, legal advice, and accounting procedures?
   Are all the laws, specifications, and standards being followed?
   What kind of check is used on charity and welfare spending?
2. What can be done if officials refuse to follow or adopt good government procedures:
   Enlist the help and support of the local newspapers, local civic and professional organizations.
   Form committees to study, plan action, and direct formal suggestions for improving functions.
   Plan public forums and arrange for speakers to discuss vital issues.
   Support state-wide organizations in sponsoring legislative action for better government.
   Don't give up when nothing seems to happen. Just the knowledge that someone is watching will help.

G. T. Byer

Bartlesville,
Oklahoma

Lithium debate

I have read with interest the recent article entitled "Fuels for Missles and Jets—Everybody in the Act" (CEP, Feb, 108). In the next to the last paragraph I was astonished by the statement credited to George Huff of Callery to the effect that while hydrogen, beryllium, and lithium were also candidates for high energy fuels, that ". . . . beryllium and lithium were ruled out at least for the moment, on grounds of scarcity and toxicity. . . ."

I have been under the impression that by this time it was a frequently told story that lithium is one of our most plentiful elements. Eight or ten years ago it might have been correct to say that lithium was scarce, at least as regards the metal and its salts—if not the basic ore. However, it is certainly now a well known fact that by reason of the AEC's urgent need for lithium in quantities previously not heard of, the production of lithium has been increased to a point where total production figures are still classified information. Also, several months ago it was publicly announced that the Commission's interest was in the extraction of the isotope which represents only a small percentage of the virgin material. The balance, in the form of lithium hydroxide, is returned to the original suppliers for conversion to industrial uses. Thus, for this article to apparently rule out the use of lithium on the grounds of scarcity, is a contradiction of fact.

With respect to the article's reference to lithium's toxicity, such a broad statement appears to be out of place unless the author is specific. This is particularly true if one compares lithium to boron.

Walter M. Fenton

Lithium Corp. of America
Minneapolis, Minn.

—It will be noted that Mr. Huff is quoted as saying "for the moment . . ." which leads CEP's editors into the interesting conjecture that perhaps both Mr. Huff and Mr. Fenton may be right in their respective statements—Ed.

Telling the Russians

W. E. Stanley's letter in the March *CEP* (p. 14) describes the best method I have seen for puncturing Iron Curtain censorship with hypodermics illustrating benefits of U. S. free enterprise.

Since the proposal is both so potentially effective and inexpensive, it should be used to the fullest extent consistent with propriety. I recommend that you send tear sheets or reprints of the letter to A.C.S. and engineering publication editors for reprinting and ultimate inclusion in pamphlets such as "Guide to Authors."

John Griswold

New York

Swanton again

A man comes along with an idea, well expressed, as to what needs to be done about classification of engineering literature (namely, Walter F. Swanton) and receives a sympathetic ear in the person of the chairman of the A.I.Ch.E. Standards Committee, and I must say "Bravo" to both. I can't quite stop there, however; I must object to the attitude of Charles L. Mantell. I think Mr. Swanton's statement of the problem is itself quite an achievement. To ask him to also have the solution to the funding part of the problem is asking too much. Let the problem be examined by some appropriate study group; let it ascertain the needs and desires of industry and government, and their willingness to pay.

Gilbert S. Bahn

Pacific Palisades,
California

Assure Highest
Product Quality in Your

Liquid Phase Adsorption

Specify

Pittsburgh Granular Carbon

If your job is to increase efficiency, reduce costs and produce higher product quality in a liquid phase adsorption process, then you'll want to know *more* about the unique benefits of using Pittsburgh Granular Activated Carbons in a fixed bed column system. Just look at these specific advantages over "batch-type" operations with powdered activated carbons:

1. Greater capacity, lower carbon dosage, lower cost. In effect, you achieve the efficiency of an infinite series of batch-type treatments.
2. Higher product quality, better colors, higher purity.
3. Cleaner operation, no slurrying or dusting problems.
4. Less equipment and maintenance—the ultimate in simplicity of operation.

What's *your* liquid phase adsorption problem? Decolorizing a solution? Refining a food product? Purifying a pharmaceutical? *Pittsburgh coal-derived Activated Carbons, used in a column system, will do a better job at lower cost.* And we have the facts to prove it!

You'll find there's a type of Pittsburgh Granular Carbon ideally suited to solve your particular adsorption problem. *Write today for your free copy of information brochure on adsorption with activated carbons.*

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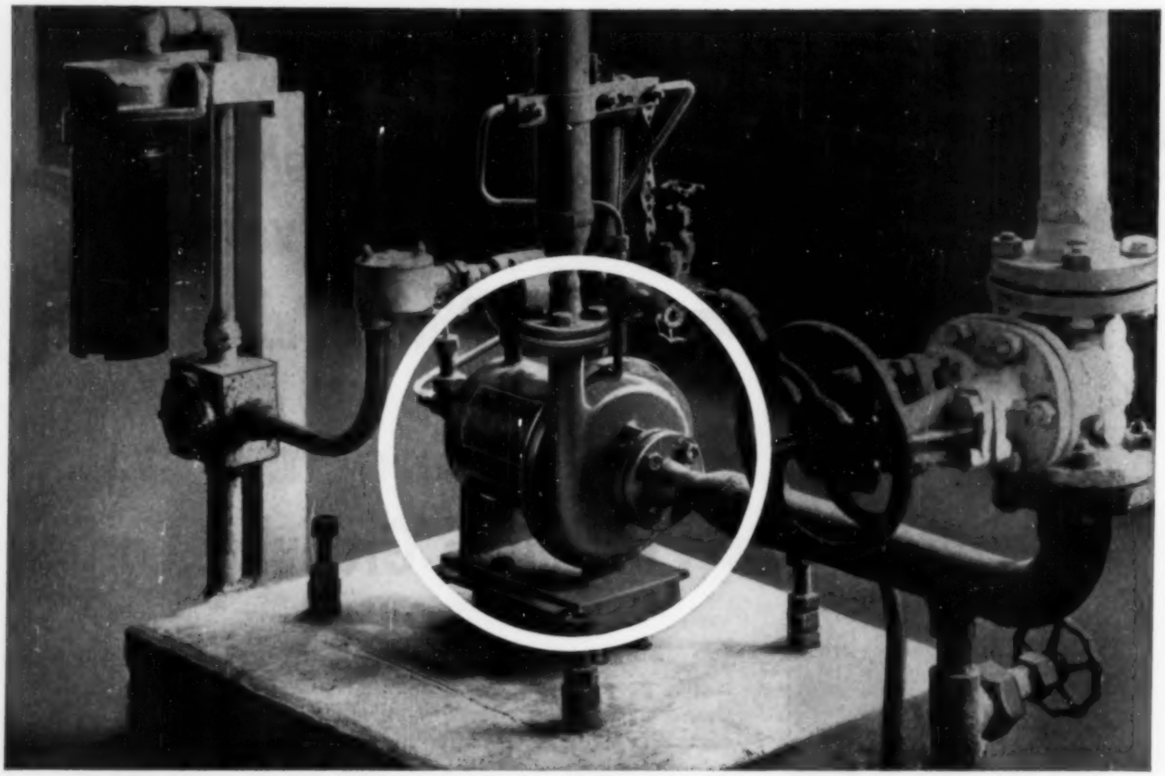


Chempump prevents H_2S leakage

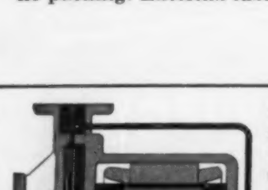
in refinery service

at Socony Mobil Oil Co.

This explosion-proof *Chempump* handles an H_2S water solution in a DEA scrubbing operation at Socony Mobil Oil Company's Trenton, Mich. refinery. It was installed a year ago to replace a conventional centrifugal pump. In a full year of zero-leakage operation, the *Chempump* has required no maintenance of any kind.

Chempump is absolutely leakproof because it is a totally enclosed unit. It has no seals, no stuffing box, no packing. External lubrication is never required—bearings are constantly lubricated by the pumped fluid itself. Maintenance is limited to an occasional inspection and replacement of bearings.

These and other *Chempump* advantages could well provide the answer to a pumping problem in your own plant. For details concerning your specific application, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.



Chempump combines pump and motor in a single, leakproof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

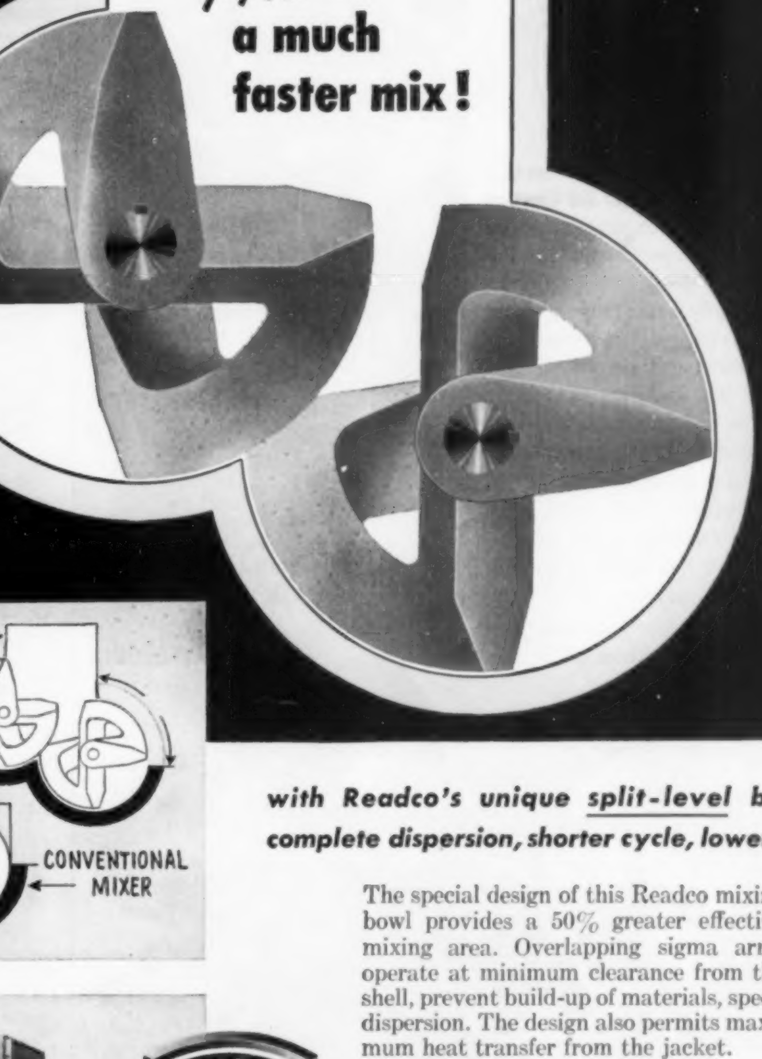
Chempump

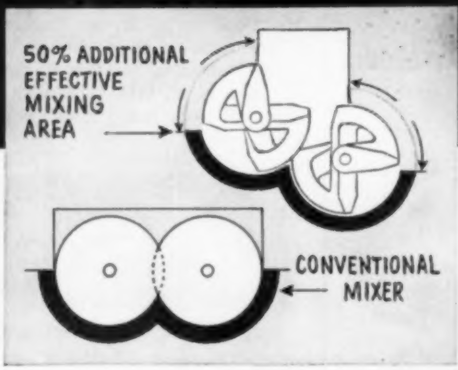
First in the field...process proved

take this unique design...

PRESTO!

a much faster mix!





with Readco's unique split-level bowl: complete dispersion, shorter cycle, lower cost

The special design of this Readco mixing bowl provides a 50% greater effective mixing area. Overlapping sigma arms operate at minimum clearance from the shell, prevent build-up of materials, speed dispersion. The design also permits maximum heat transfer from the jacket.

You'll get complete dispersion, consistent mixing, in substantially shorter cycles. Working capacities range from 150 to 900 gallons. Write for complete information.

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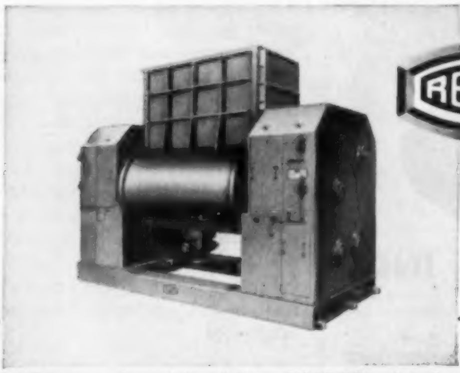

Whatever the mixing job: a READCO mixer!

READ STANDARD
York, Pennsylvania
A Division of
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A Perfect Fit

In a like manner **Graham Surface Condensers** and **Steam Jet Ejectors** are tailor made for your particular needs—truly a perfect fit! The finest possible performance, proportioned to efficiently fit your space conditions plus rugged construction for a minimum of upkeep—are the result of building over ten million square feet of Surface Condensers throughout the past quarter century.

The many practical features that are incorporated with great detail into each Graham design conclusively prove that there is no substitute for experience.

Call Graham on your next condenser problem without obligation.

See our insert in Chemical Engineering Catalog, pages 903-906, and Refinery Catalog, pages 505-508.

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Heliflow Corporation

about our authors

K. D. Timmerhaus, and his group, are doing their pioneering hydrogen-deuterium separation work at NBS Cryogenic Engineering Laboratory at Boulder, Colo. Timmerhaus himself is an associate professor of chemical engineering at the University of Colo. Explaining how he happened to get into this work, Timmerhaus says, "My main field of interest has always been distillation. So when I came here to Colorado teaching, and they were able to get the money for doing some work on this . . . they contacted me over at chemical engineering." Timmerhaus' associate, *D. H. Weitzel* is a project leader in the Cryogenic Processes Section of the NBS Cryogenic Engineering Laboratory. Another associate in this unique work is Ph.D. candidate *T. M. Flynn*.

Considerable international interest is being shown in Timmerhaus' work mainly based on two factors: the need of foreign countries for heavy water for reactors which use a low grade of uranium; and the strong possibility of using the new separation columns in conjunction with ammonia plants and thus producing heavy water as a by-product of ammonia production. Somewhat ironically, Timmerhaus says, "the first application we are actually going to use it for is at the University of Chicago where they want completely pure hydrogen, some that has been stripped of all HD—they want to get the stuff we're going to call our waste product."

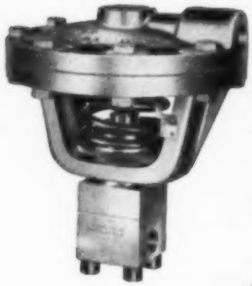
Authors Hall, Miller, Timmerhaus.

Fred Kurata, authoring the work on determining liquid viscosities of normally gaseous hydrocarbons at low temperatures and high pressures, has been working with his co-authors in low temperature phase and volumetric behavior for the past ten years. A professor of chemical engineering at the U. of Kansas, Kurata has been working on this project for four years, says, "This problem has been one of the most difficult experimentally that we have tackled." Until they first got consistent results a year ago, the group had even considered discarding the approach.

Well known to *CEP* readers are authors *C. J. Marsel* of N.Y.U., *J. Hap-*

continued on page 28

MINIATURIZATION From Pilot Plant to Process



"BANTAM" 500 SERIES VALVE

Throttling "Bantam" Diaphram Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 316 stainless steel and Teflon only wetted surfaces, low in hysteresis size and weight, 2000 series "Bantam" Control Valves available for on-off service.

MINIATURE DIAPHRAGM OPERATED SHUT OFF VALVE

Body PVC, diaphragm neoprene, diaphragm head aluminum. Body and operator 2" dia. x 1¾" high. (⅛ or ¼ NPT).

"DEMI" PACKLESS VALVE

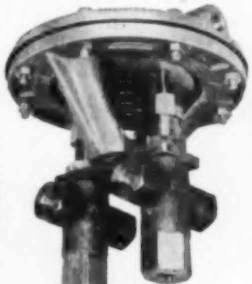
For services when packing is a problem, manifolding of small valves in one unit at low cost. For services up to 750 psi and 500°F, screw, toggle, or diaphragm operated, the "DEMI" line is ideal for panel mounting up to five valves in one block.

"DEMI 54"

5 Valve Manifold for integral mounting on cleanout type Manometer. Packless design, 2 shut off valves, one bypass valve, 2 vent valves. Other 3 or 5 valve models available with or without special manometer mounting.

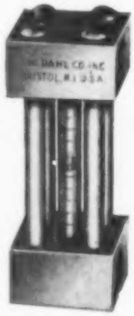
WHIFFLETREE OPERATOR

Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.



AIR RATE INDICATOR

Top and bottom housing, 1¼" square anodyzed aluminum barstock, combination column studs and gauge protection. The ⅛" IPS ports may be relocated by removing column studs and rotating top or bottom housing. Standard calibration indicates 0 to 2 standard cubic ft. per hour of air. Other models available with built-in toggle actuated packless valves or needle type valves for precise control or special porting or additional ports to suit your requirements.



MANUAL RESET

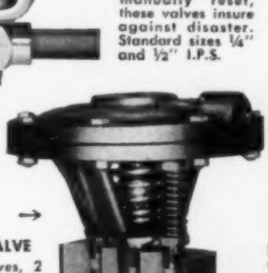
Wherever control air on dangerous or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

SAUNDERS VALVE, AIR OPERATED

Plastic valve, 2" and below, metal valve 1" and below. G. W. Dahl Co., Diaphragm Operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

MINIATURE THROTTLING CONTROL VALVE, TOP MOUNTED MOORE POSITIONER

Compact, accurate rugged. High lift, positioning accuracy, low cost, and low in weight and size. Body, bonnet and blind head of barstock construction. Valve sizes up to 1", screwed or flanged. Trim Cv, 12.0 to 0.001. Pressures, 0 to 2000 psi. Temperatures, Minus 400 to Plus 1000°F.

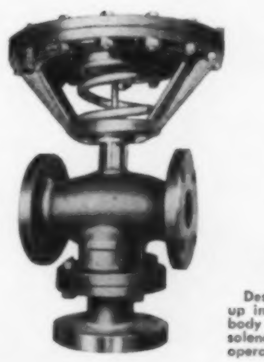


BLOCK VENT VALVE

3 balanced valves, 2 reverse acting and 1 direct acting, actuated by one operator. With 0 to 3 psi control air, the 2 reverse acting valves are closed, center valve vented. At 6 psi control air, all valves closed. At 12 to 15 psi, the 2 reverse acting valves are open and the vent valve is closed, allowing free flow through body. Design pressure 1000 psi. Teflon, Chevron packing. Teflon seating for tight shut off.

DIAPHRAGM OPERATED 3-WAY CONTROL VALVE

Aluminum diaphragm operator, stainless steel body and trim, Teflon packing with Teflon seating for tight shut off. Available up to 2", flanged or screwed.



MINIMUM DISPLACEMENT PACKLESS VALVE

Designed specifically for minimum hold-up in valving capillary tubing. 1¼" dia. body available with special bonnet for solenoid or diaphragm operation, or hand operation.

REPRESENTATIVES IN PRINCIPAL CITIES
Write us for complete technical information, or for the address of our representative in your area.

GEORGE W. DAHL COMPANY, INC. 86 TUPELO STREET, BRISTOL, R. I.

IN MIXERS...tough buyers look at the bearings

Specifically, they look for oversize, heavy duty, high capacity bearings like the ones in this Philadelphia Mixer.

Their reasons are many. Oversize bearings mean the mixer will easily take maximum thrust and heavy unbalanced mixing loads.

Extra large bearings permit extra large output shafting. Shaft deflection is kept to an absolute minimum. Stuffing boxes need less maintenance. Mechanical seals last longer. You don't need steady bearings in tank bottoms.

Heavy duty inboard bearings give extra rigid support. Shaft run-out is minimized. Spiral gears run more smoothly . . . have longer life.

Oversize thrust bearings mean you can use standard Philadelphia Mixers for high pressure, closed tank applications.

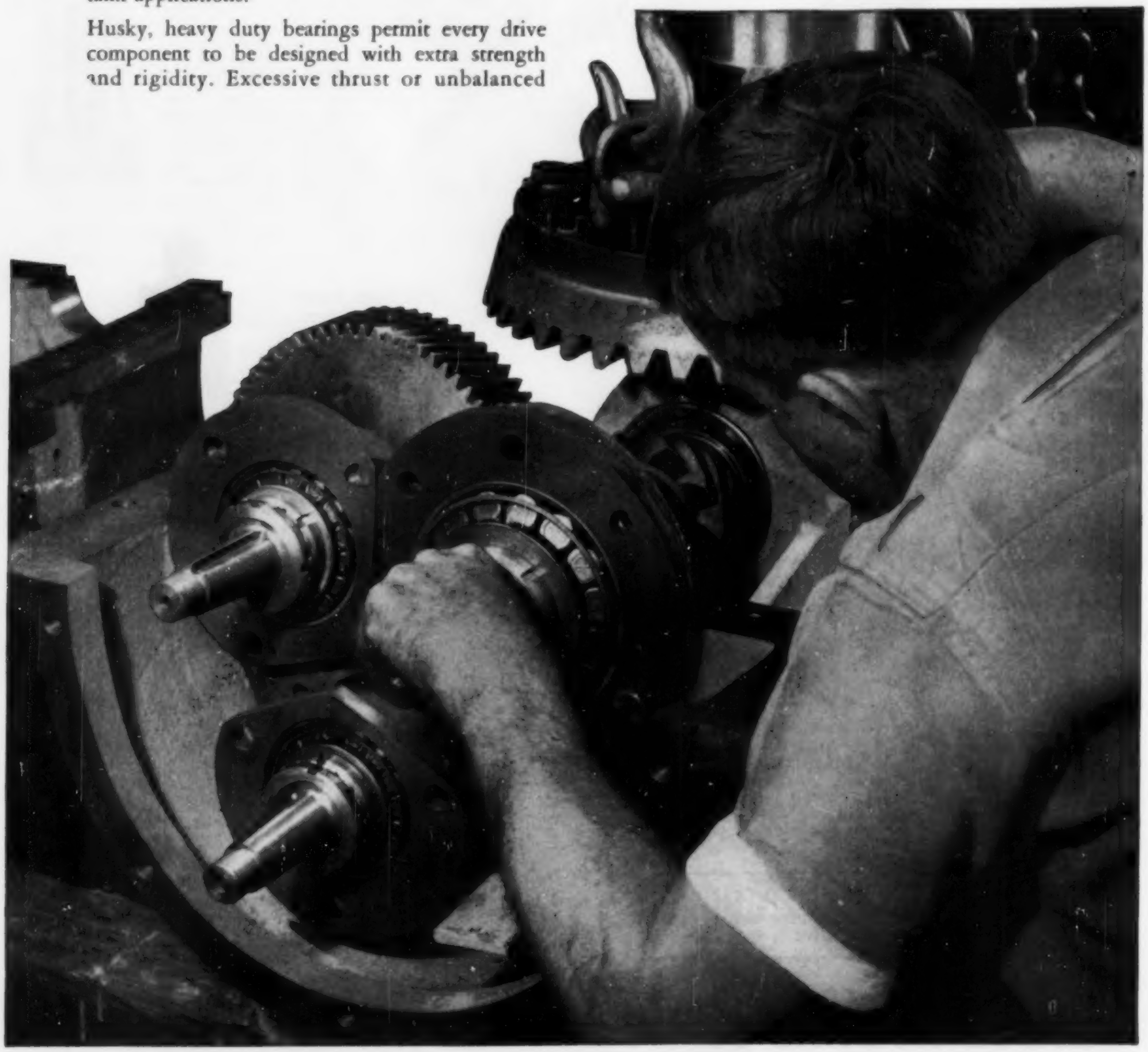
Husky, heavy duty bearings permit every drive component to be designed with extra strength and rigidity. Excessive thrust or unbalanced impeller loads simply can't cause shaft deflections which might damage the gearing.

Tough buyers look at the price too. And, you'll pay no premium for a Philadelphia Mixer. We are the only manufacturer that designs and builds the whole mixer. We control production and costs. We can *afford* to give you more mixer per dollar.

Write for Catalog A-27. It contains all the information needed for you to select your own Philadelphia Mixer. Philadelphia Gear Works, Erie Ave. and G Street, Philadelphia 34, Pa.

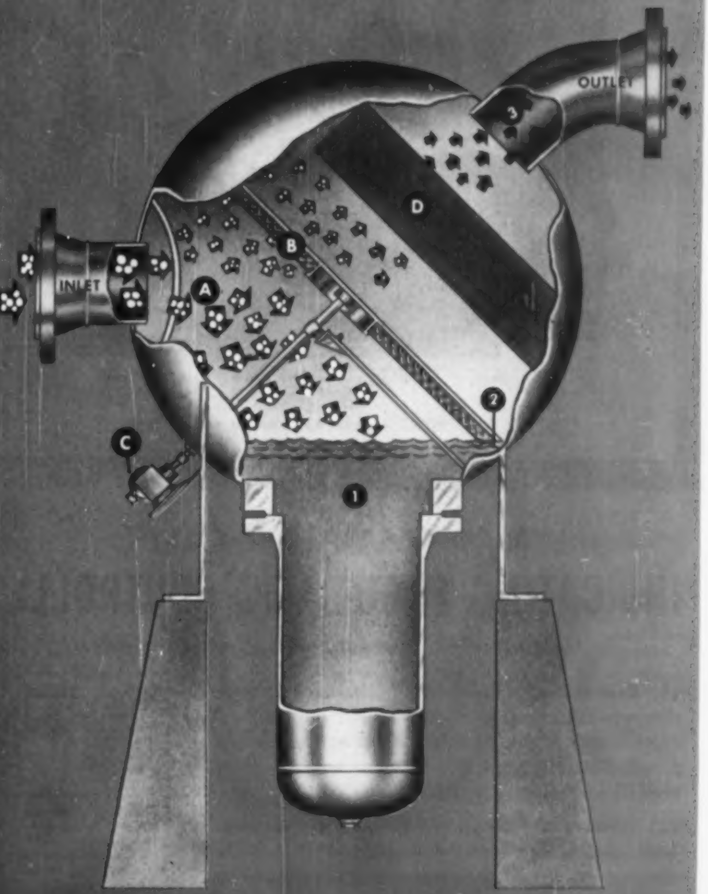
philadelphia mixers

Offices in Principal Cities



SCRUBOSPHERE* ...

... FOR *Cleaner Gas* AT *Less Cost!*



*PEERLESS SPHERICAL DUST and LIQUID SCRUBBER FOR GAS PIPELINES

LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

- The **dust removal ability** of the SCRUBOSPHERE **is superior** because it utilizes wetted surfaces for dust collection which are much more closely spaced than in conventional equipment.
- **Oil loss is minimized** because the oil used to wet the dust collecting surface is lifted mechanically instead of bubbling gas through the oil which results in foaming and loss due to creation of hard-to-separate fine particles.
- **Maximum performance and low cost** — The spherical design means high capacity and performance because it provides maximum dimensions for the contactor and mist extractor which normally are limiting factors in scrubber designs. The vessel cost is reduced because required vessel thickness is only one half that required for cylindrical vessel of same diameter.
- **Versatility** — separates solid and liquid particles with equal efficiency.
- **Low pressure drop** — ½ to ¾ psi at rated capacity depending on nozzle size.

PEERLESS MFG. CO. DALLAS TEXAS

PEERLESS MANUFACTURING CO.

P. O. BOX 13165 DALLAS, TEXAS

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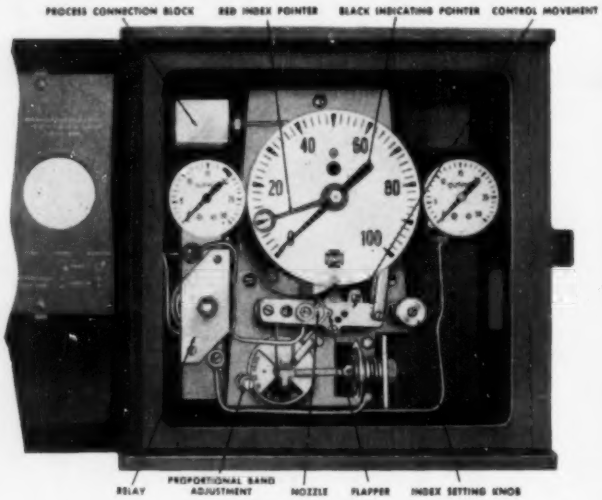
Write for test data showing dust removal and oil loss of Peerless Scrubosphere as against conventional dust scrubber.

OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"



THE USG "PILOT"—Case: 8½" Square and 4" Deep

A COMPACT, LOW-COST*

INDICATING PNEUMATIC CONTROLLER

for pressure . . . temperature . . . other variables

(1) Control modes to suit your process: Two-position with differential gap (1 to 100%) . . . proportional (1 to 150%), alone or with automatic reset or rate action. Control mode or control action (direct or reverse) easily altered in field.

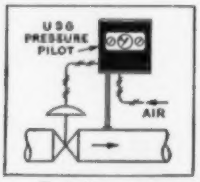
(2) Variable and set point both indicated on large dial: Black pointer indicates reading on 3½-inch dial (6¾-inch scale length). Red circle-tipped pointer spots location of set point.

(3) High accuracy and sensitivity at low cost: Accuracy of 1% of range over middle half of scale. Sensitivity less than 0.1% of scale at 100% proportional band setting . . . compares favorably with higher-priced controllers.

(4) Simplified maintenance and repair: Precalibrated measuring element can be removed for range change. Other basic components, even entire control chassis, can be removed for easy maintenance.

(5) Controls a broad range of variables: Pressures from 30" Hg vacuum to 10,000 psi. Temperatures from —350 F to + 1000 F. Can be adapted to control many other variables, including liquid level.

**Sample price: $126.00 for unit with 316 S.S. Bourdon tube, range 0-600 psi, proportional control 1-100%.*



Typical pressure reducing service

Can be panel or surface mounted

Can be valve mounted

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Write for Catalog 510 . . . Gives complete specifications and description of the USG Pilot as well as pneumatic transmitters and receivers for process instrumentation. Send for your copy today, or contact your nearest USG distributor.

UNITED STATES GAUGE USG

DIVISION OF AMERICAN MACHINE AND METALS, INC., SELLERSVILLE, PA.

about our authors

from page 24

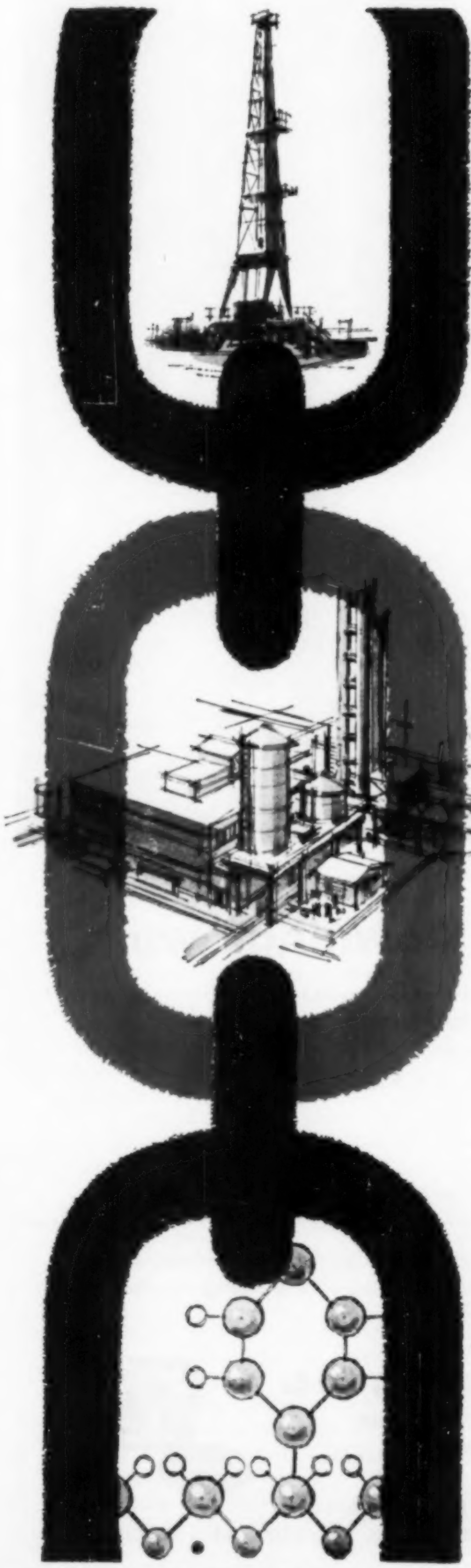
pel also of N.Y.U., and *W. R. Collings* of Dow Corning. Marsel and Happel give more of their work on high-energy hydrocarbon fuels, emphasizing methods of production of such "extra-energy" hydrocarbons as the acetylenes and cyclo-propanes. Collings tackles the often difficult management problem of the efficient functioning of the various parts of a large technical organization, specifically—the development of a smoothly functioning interconnected pilot-plant laboratory-office system.

T. T. Miller, president of Grace's Polymer Chemicals Div., explains that his work on projecting profitability has been a long-range project, has grown greatly since he first undertook the subject. Going into Dewey & Almy right out of MIT (one of the first graduates of the then new Business-Engineering combination course) in 1922, Miller became a sales engineer. Soon he was off to Europe (1925) for a three month visit to see if there were any sales prospects for Dewey & Almy—he stayed ten years, indicating that there were sales prospects. Rapidly, Miller became European Sales Representative for the company, then European Sales Manager (in 1926 when the only man he managed was himself), and finally returned home in 1935 to become General Sales Manager of the company. By 1940 he was V-P Sales, and in 1948 became one of the first Marketing V-Ps in the country. In 1954 W. R. Grace acquired Dewey & Almy, and Miller progressed to his present position by 1956. All of this experience, much of it concerned with new products, has gone into Miller's present work in *CEP*.

E. J. Henley, assistant professor of chemical engineering at Columbia U., has worked extensively in the field of radiation effects scale-up with his coauthors. The present paper in *CEP* is actualy the result of the combination and expansion of four papers, one by each author. Henley, who did his Ph.D. work in this field, feels that the problems of nuclear energy are largely the problems of chemical engineering.

R. V. L. Hall, staff metallurgist at Bridgeport Brass Co., has been connected with corrosion investigations since 1939, has been engaged in the work discussed here for the last seven years.

J. F. Reid joined Cambridge Wire Cloth Co. in 1942, is a recognized authority in the highly specialized field of metal-mesh belts.



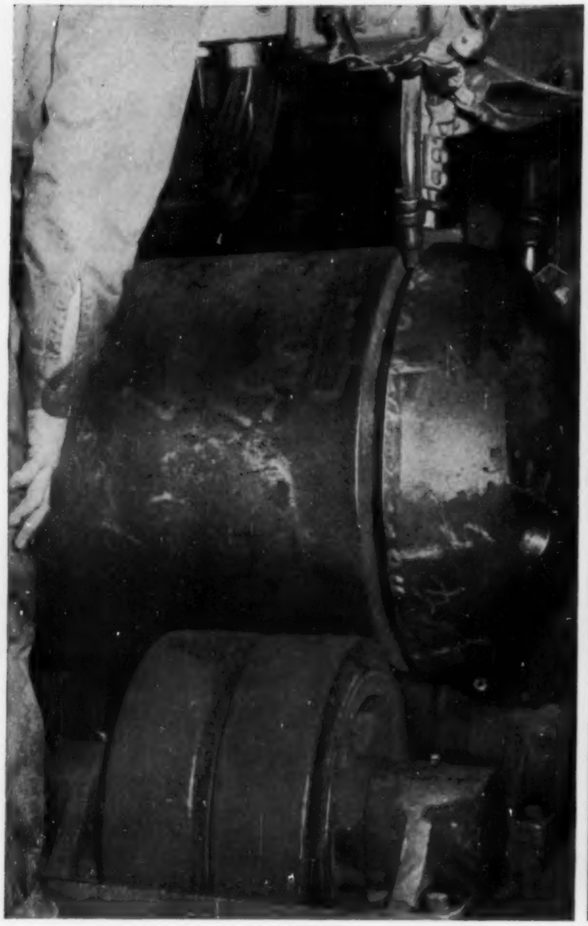
Blaw-Knox supplies vital link in Cosden's crude-to-plastic chain

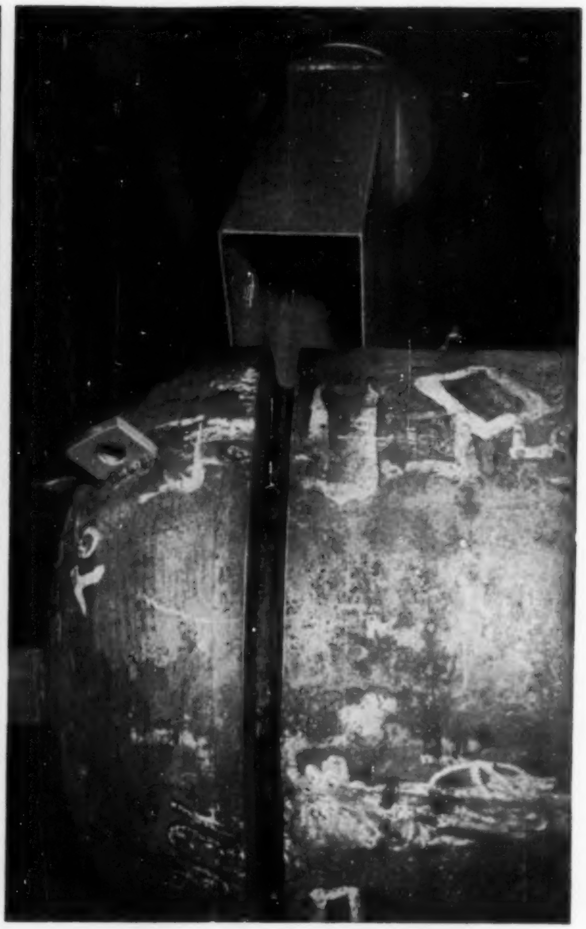
From crude oil to ethylbenzene to styrene and finally polystyrene—with this pace setting program, Cosden Petroleum Corporation makes oil industry history. In designing and building Cosden's polystyrene plant, Blaw-Knox proudly joins this enterprising company in the vanguard of petrochemical activity.

A unique combination of know-how in resin manufacturing, chemical production and petroleum refining has made Blaw-Knox a leading contractor for industry's most progressive projects.

Perhaps this background of over 90 plastic and resins facilities can be helpful to you. Contact our engineering staff for a conference. Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D.C. and San Francisco.

for plants of distinction . . . BLAW-KNOX





WELDING... **X-RAYING...**

2-inch-thick seam at Downingtown

Item:	Air Dryer Cylinder
Material:	Carbon Steel
Thickness:	Head, 2"—Shell, 2-5/16"
Design Pressure:	3200 psi
Hydrostatic Test Pressure:	5400 psi
Design Temperature:	450° F.
Stamping:	National Board and ASME

X-rayed and stress relieved. Inspection by purchaser and Hartford. One of 8 identical units. The rest of our plant equipment is geared to our capacity for welding 2-inch-thick material and lifting 80 tons. Write for bulletins.

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Hackney

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

JUNE • 1958 **trends** / Economic Picture At Mid-Year.

As mid-year approaches, bringing the end of the second quarter of the year, the economy comes to a more or less critical point. Results of company operations in June should be the key as to whether the recession is about to turn upward, whether things will stay level, or whether a new downswing is in prospect.

Operating results of companies in the June quarter will, in a number of cases, determine whether dividends will be maintained at present rates. And dividend cuts in themselves could be a factor in dragging down business.

So far statistics and business reports in April, and through May as far as available, indicate that affairs are not getting progressively worse. Even though industrial output as reported by the Federal Reserve Bank fell to 126% of the 1947-49 average, lowest since October, 1954, there are a few little signs of life. The recession has so far been nearly all in what are called durable products, notably steel and automobiles.

There has been a slight upturn in steel operations although the industry looks for no substantial improvement until later in the year. Meanwhile higher wage schedules in the steel industry, to come around July 1, will put pressure on steel firms to advance prices as much as $10 a ton. This poses a problem with operations in their present slump, but a coming price hike might stimulate some short term buying in June. There has been already a slight flurry in buying ferro alloys for stainless steel, though it is too soon to be sure of its significance. One bright spot is demand for tin plate going to the still undepressed food canning industry.

An exhaustive study of the steel industry, made by a financial firm recently, indicates that although production has been running at an annual rate of only 70 million tons, consumption has been at the annual rate of 90 million tons. From this they reason that the industry should be able to get back to 65% operations in the final part of the year from the present less than 50% rate. Pessimism in the motor industry, however, continues, with estimates that car output this year may be no more than 4 million.

On the more cheerful side is the fact that consumer income at around $342 billion annual rate continues to hold above the $341 billion 1957 level and to show moderate monthly gains. Employment continues to rise slightly and unemployment to decrease slightly, although not enough to offer strong encouragement. Consumer spending, of course, traditionally holds up even after heavy industry starts to decline. In other set-backs consumer spending held up well, so this cheering factor is not in itself conclusive.

Of greater significance on the brighter side is the recently issued government figures showing that inventories in the first quarter were reduced at a higher annual rate than in any year on record. The rate of liquidation in the first quarter was $9 billion a year compared with $2.7 billion a year in 1947 and $1.9 billion in 1954. The current rate is even more drastic than in 1932 in dollars, although, of course, in that year of the Great Depression prices were much lower. The interesting point about this is that industry apparently has really learned a lesson from former recessions and clears its own decks rapidly.

The chemical industry continues to be far from downhearted, although very few firms can say more than that business is holding and not continuing on the toboggan slide of late '57 and early '58.

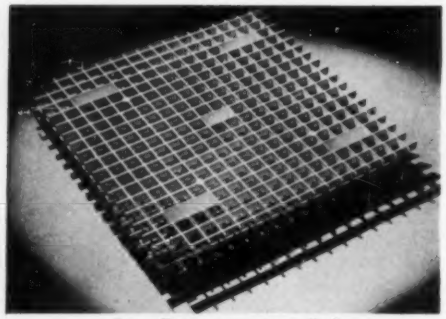
Several large chemical firms look for better results in earnings in the June quarter than in the March quarter. They go so far as to say privately that they look for slow continued betterment over the balance of the year. Reasons for this improvement differ with the companies, and are not necessarily tied in to any real business improvement. New capacity, operation economies and lower plant start-up costs may all be factors.

One more cheerful straw is better rayon business with one of the largest firms seeing marked improvement in sales and earnings in the June quarter over the March quarter.

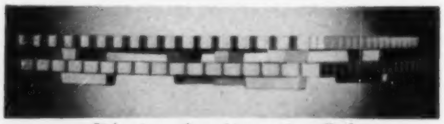
Much harder to evaluate and much more disturbing for the long range future is the confused and alarming foreign situation on several fronts. The experience of Vice President Nixon in Latin America is said by him to reveal popular discontent with regard to economic conditions, directed toward the United States. The Middle East continues to boil. Both of these areas may mean a threat to our imports of oil, and concurrently difficulties in Great Britain and Europe who need Middle East oil.

announcing

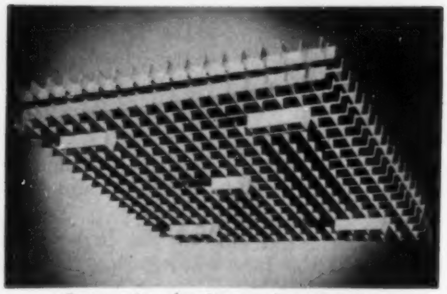
FLUOR'S NEW *poly*-GRID



Overall top view as installed



Side view of packing as installed



Bottom view showing spacing supports

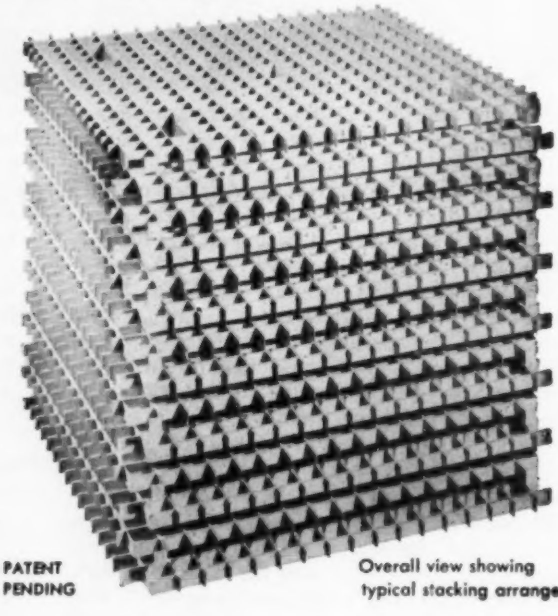
MORE COOLING IN YOUR EXISTING TOWER

To increase the throughput of your existing counterflow induced draft cooling tower, Fluor Products Company now offers "Poly-Grid" packing.

This revolutionary packing provides greater cooling surface — greater overall heat transfer; yet construction is open, and pressure drop low.

"Poly-Grid" is available in high impact polystyrene or linear polyethylene to meet all water conditions.

Fluor "Poly-Grid" packing allows you to cool more water under existing operating conditions, or to realize extra cooling of present throughput — all at minimum capital expenditure.



PATENT PENDING

Overall view showing typical stacking arrangement

Contact your nearest Fluor Representative for details.

POLY-GRID can be easily installed in any counterflow induced draft cooling tower—regardless of make or model!

Call him today!

FLUOR PRODUCTS COMPANY

A DIVISION OF THE FLUOR CORPORATION, LTD.

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CEP opinion and comment

THE AREA OF COOPERATION

Normally members assess the functions of a professional society from a standpoint that is closely personal. They evaluate the good that the organization does them in terms of publication pages, meetings, local section functions, committee activities, contacts with others in their profession. Yet there is another area in which the professional organization works for the good of the profession, one that the average member seldom thinks about. This might be described as the area of cooperation, and it is particularly in this area that the A.I.Ch.E. represents chemical engineering to the rest of the world.

This facet of the Institute is emphasized now that after fifty years the A.I.Ch.E. has become a founder society in the United Engineering Trustees. Last month President Holbrook signed the final agreements in the presence of the officers of the four other founder engineering societies. The Institute is now assuming for the chemical engineer the same responsibilities that their societies have shouldered for the civil, mining, mechanical, and electrical engineers. The culmination of several years work, this new status is a source of considerable pride.

A brief enumeration of the ways in which we have represented chemical engineers and chemical engineering this year manifests the work of the Institute in this area.

Such obvious activities as the Nuclear Congress, which we managed, and the meeting held with the C.I.C. in Montreal need not be considered here, but in April we represented American chemical engineering at a U.S.E.C. meeting in New York City, attended by the representatives of all the engineering societies of the United States and of European countries; and at present the staff is working on a cooperative meeting with the A.S.M.E. to be held in Chicago, at the Edgewater Beach Hotel, from August 18 to 21.

Seldom does the average member realize how many people work for him and he pays little attention to these assiduous representatives who give up their time, who pay their own expenses, and whose only reward is the inner satisfaction of a job well done. On the News & Notes page are tabulated both in April and again in this issue some of the extra tasks that come our way as the professional society for chemical engineering. The Institute is represented as often as possible at the inauguration of presidents of engineering colleges, and we are frequently asked for official representatives to other technical societies. The pages of the directory show many interesting examples of representation to other groups, such as the A.S.A., E.C.P.D., National Research Council, M.C.A., and A.A.A.S. Government agencies, too, ask us for representation—delegations to go to Washington to present the chemical engineer's point of view.

This month in Philadelphia there will be another kind of representation when delegates of engineering societies from abroad and from the United States meet with us in Philadelphia to commemorate the Fiftieth Anniversary of the A.I.Ch.E. Even though the actual representation will be from other societies to us, the over-all picture of the week-long celebration will be of the A.I.Ch.E. representing chemical engineering to the whole world. Meetings such as this, together with the countless groups and functions to which we send delegates, signify how an organization of professional men can represent the best interests of the profession to the public. F.J.V.A.

IN PRESSURE OR VACUUM DISTILLATION METAL PALL RINGS PROVIDE MAXIMUM SEPARATION—MAXIMUM CAPACITY

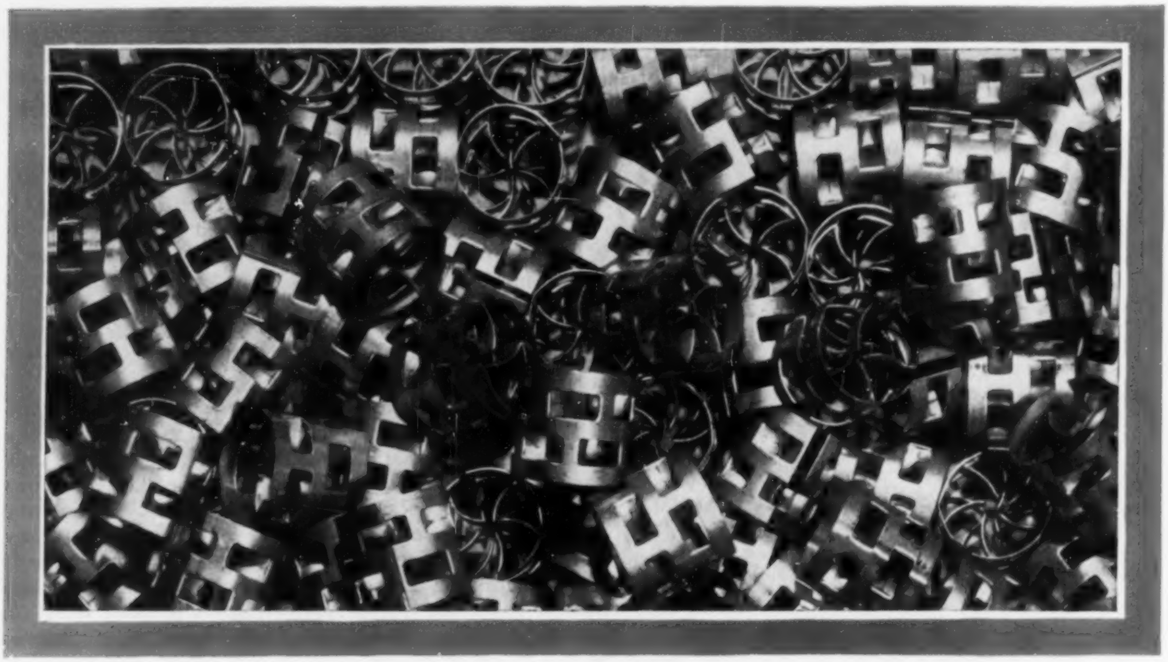
. . . with a minimum size shell

The superiority of metal Pall Rings is nowhere more clearly established than in distillation operations. Here two characteristic advantages of the Pall Ring come into play: (1) extremely low pressure drop, and (2) exceptional internal distribution at the low liquid rates employed in distillation.

In bubble cap towers or distillation columns packed with raschig rings the higher pressure drops necessitate higher pressures and higher boiler temperatures. Not infrequently the temperature required is so high as to invite product break down.

Not only can lower pressures and lower boiler temperatures be employed when the column is packed with metal Pall Rings but the fractionating efficiency of the column can be improved as much as 25% to 40%. In new construction the higher efficiency of the metal Pall Ring permits substantially smaller shells to be employed.

Metal Pall Rings are now being made in the ⅝", 1", 1½" and 2" sizes from carbon steel, the 18-8 series of stainless steels, monel, inconel, titanium, aluminum and copper.



The metal Pall Ring is similar to the raschig ring in that height and diameter are equal. In the raschig ring the interior wall is mostly inactive providing little or no active contact between phases. In the metal Pall Ring, sections of the wall are stamped and bent inward, thus making the inner wall an active, working surface. Pressure drop is less than half that of raschig rings, resulting in a much greater capacity per unit of tower area.

Write today for engineering data on metal Pall Rings.

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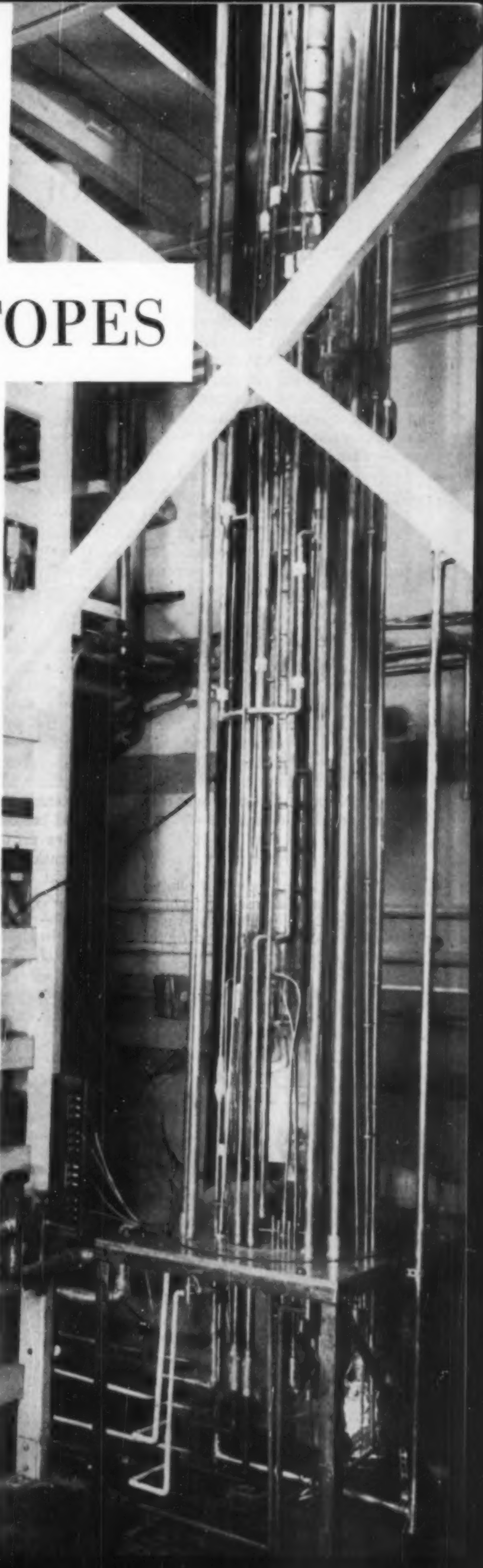
Low temperature distillation of HYDROGEN ISOTOPES



K. D. TIMMERHAUS*, D. H. WEITZEL, AND T. M. FLYNN*
Cryogenic Engineering Laboratory
National Bureau of Standards, Boulder, Colorado

The purpose of low temperature distillation research performed by the NBS Cryogenic Engineering Laboratory is to evaluate some of the unknown parameters necessary in the design of hydrogen isotope separation columns. These columns are essential for heavy water plants similar to the 6 tons/year Farbewerke Hoechst (Germany) or the 2.5 tons/year Toulouse (France) installations. Distillation is also thought by some authorities to be the best approach for large quantities of deuterium, the only practical fuel for fusion reactors of the future.

Considerable interest in this work on both a national and international scale has been displayed in the past few years. This article reports on the experimental program at the NBS (Boulder, Colo.) laboratory. Work has been in progress for about three years, and is presently in the pilot plant stage. Consideration is being given to the combination of larger units with ammonia production facilities because that is where the largest hydrogen capacity is. This has been done in France, offers an important commercial potential in which heavy water could be produced as a "by-product" of ammonia.

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Figure 4. Pilot Plant column. Vacuum jacket is removed to show interior piping and heat shields.

The Pilot Plant at Boulder

TYPICAL low-temperature processes generally separate the components of a gaseous mixture by liquefying part or all of the feed gas and distilling it. The separation of hydrogen isotopes is easy by ordinary distillation standards based on relative volatilities. Yet large-scale distillation of liquid hydrogen to recover natural occurring amounts of hydrogen deuteride, although considered a number of times, has until recently been rejected because of lack of design data and because of the problems expected from operation at extremely low temperatures. Accordingly, studies have been carried out for some time at the National Bureau of Standards Cryogenic Engineering Laboratory in Boulder to determine the design parameters for a liquid hydrogen distillation unit. Recently a relatively large-scale pilot plant unit has been put into operation, and it is the sequence of information gathering and design steps leading up to the successful operation of the pilot plant that is the subject of this article.

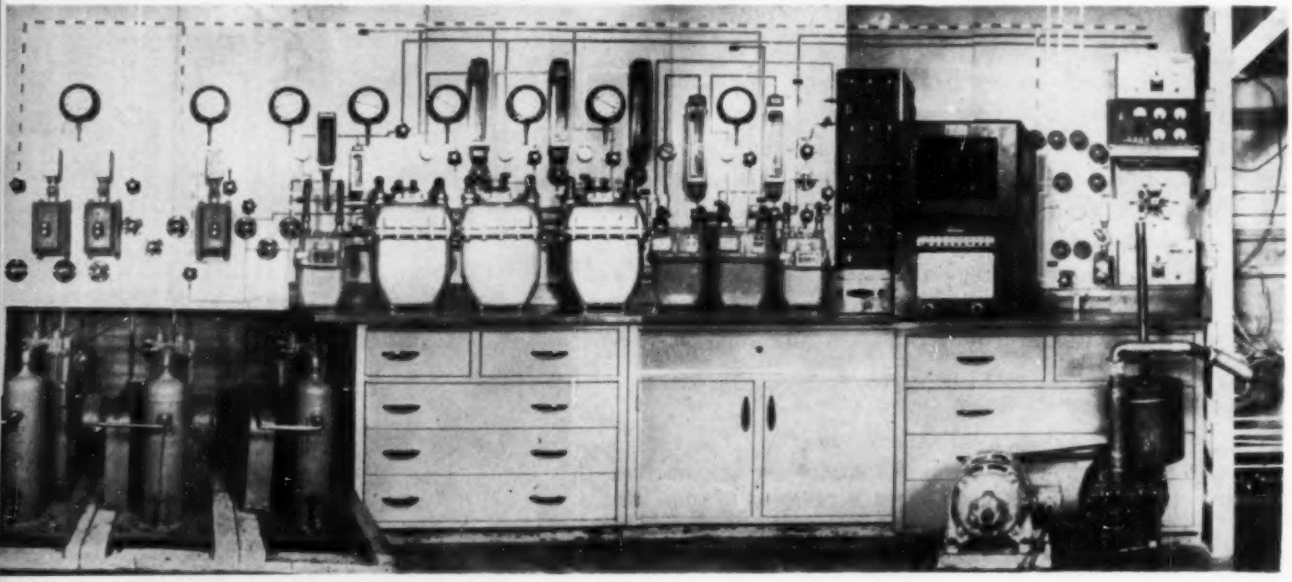
Figure 3. Control panel of pilot plant. Vacuum jacket surrounding column is shown in down position at right; circulation and feed-system compressors at left.

It is now possible to make an improved design of a column or series of columns which will increase the concentration of HD in H_2 from its natural abundance of 1 part in 3500 to any desired concentration. Since the initial concentration to about 1 part in 300 is the most difficult, the pilot plant scale column has been designed and constructed to accomplish this specific separation. The design is based on the assumption that the parameters obtained experimentally for the H_2 - D_2 system are applicable to the H_2 - HD system.

A compromise of various factors led to the selection of a column operating pressure of 1.3 atm. and a recovery in the bottoms of 85% of the HD fed to the column. The pressure selected eliminated the danger of air leaking into the column and provided a satisfactory temperature difference for heat exchange in the condenser and the reboiler. Limitations on column size dictated the recovery value for a fixed-bottoms concentration of 3% HD. However, under commercial economic operations, recoveries greater than 85% would be possible.

For a column pressure of 1.3 atm. over a concentration range of 0 to 3% HD in H_2, the average relative volatility $\alpha_{H_2 - HD}$ is 1.590 as determined with the aid of Equation (3) and the data of R. B. Newman (*10*). This determines the vapor-liquid equilibrium curve. The minimum reflux ratio (*36*) for these specified conditions is 1.42. An external reflux ratio, L/D, of 2.0 was chosen for this design. This 40% increase over minimum reflux ratio is high by low-temperature distillation standards since reflux is difficult to obtain in low-temperature columns (*33*). However, it was important in this design because of laboratory space limitations, to keep the column as small as possible. The number of theoretical plates and hence the height of the column is reduced by choosing a larger reflux ratio, and the experimental value of the column is not decreased.

The conventional McCabe-Thiele (*24*) graphical method for analysis of binary mixtures was also applied here to determine the number of theoretical plates necessary for the separation. Constant molal overflow was assumed. This assumption is valid if molal heat of vaporization is constant and the column operates adiabatically. The design conditions as given above result in a temperature difference of only 0.05°K. between the condenser and the reboiler. This difference is small enough to maintain the



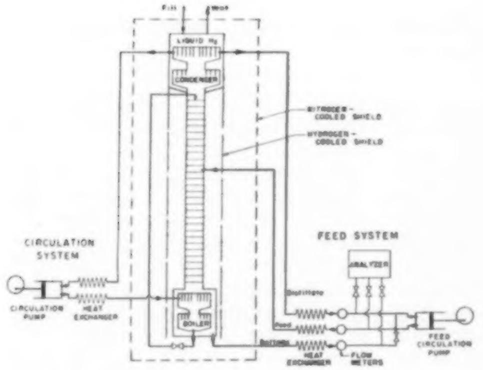


Figure 2. Flow diagram for pilot plant column.

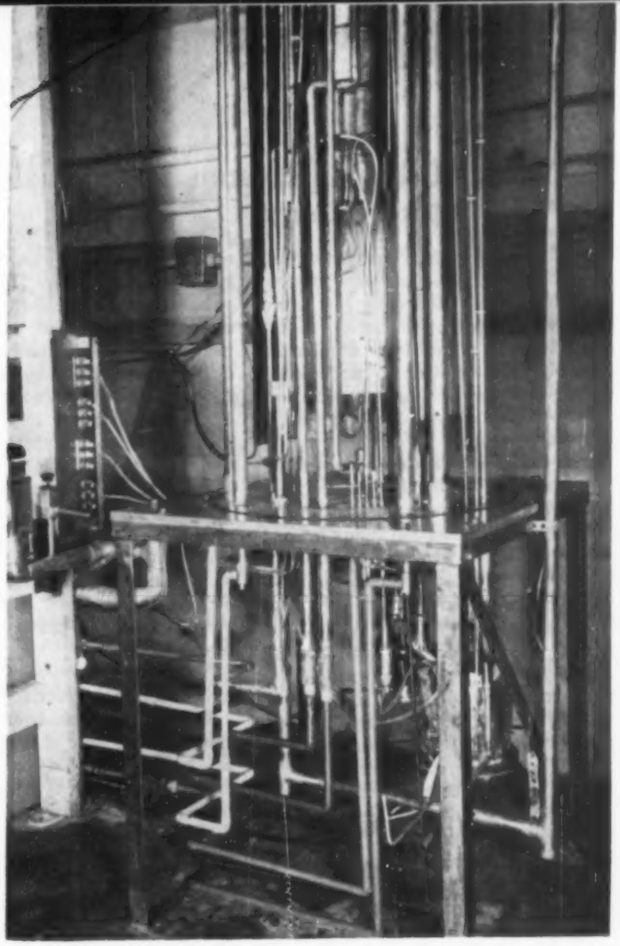


Figure 5. Base of pilot plant column. Vacuum jacket is removed. Thermal expansion bellows, diffusion pump, and heat shields.

molal heats of vaporization essentially constant throughout the column. Thus the first condition for constant molal overflow is satisfied.

It would seem that since the column was to operate at such a low-temperature level there would be a high rate of heat leak to the column. However, considerable experience has been gained over the past few years in handling and storing cryogenic fluids, so that it is now possible to design insulation systems which reduce heat leak to a negligible amount. Such a system will presently be described, the heat leak calculated and shown to be negligible. Hence the column will operate under essentially adiabatic conditions, which fulfill the other requirement for constant molal overflow.

Calculations show that 11.3 theoretical plates are required in the stripping section and 9.4 theoretical plates are necessary in the rectifying section. Thus 20.7 theoretical plates are required to effect the desired separation. The number of actual plates required can be determined by dividing the number of theoretical plates by E_o, the over-all plate efficiency.

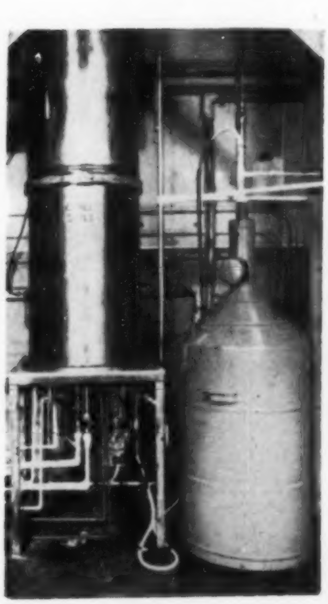


Figure 18 shows that E_o depends upon the vapor velocity in the column and varies from 30 to 80%. Any E_o within this range could, of course, be selected and a column designed which would function properly. It remains only to select a reasonable value of vapor velocity and a corresponding value of E_o. A value of E_o somewhat higher than the midpoint of the data was selected to insure a reasonable number of actual plates and allow a wide range of operation for this experimental column. The value of E_o chosen was 70%, corresponding to a vapor velocity of 0.216 ft./sec. The number of actual plates required is therefore nearly thirty plates. The feed will be introduced between the 13th and 14th plate from the top.

Figure 19 shows that E_o is independent of plate spacing in the range 2⅞ to 5 in. As a rule, in low-temperature distillations, plate spacing is made as low as possible to reduce the size of the column. It was felt that for a column of this diameter a 4-in. plate spacing was a minimum safe value. This resulted in a column length of 10 ft., exclusive of the reboiler and condenser.

The difference in diameter between laboratory scale and pilot plant apparatus is somewhat arbitrary. However, it was felt that an increase in column diameter from 1⅞ to 6 in. would place the column in the pilot plant category and yield information directly applicable to commercial-size units.

The plates were constructed of 40-mesh screen, with a weir height of ¾ in. As indicated by the small columns, a downcomer area of about 10% of the column cross section was required. Plate layout was changed slightly from the previous plates by placing the downcomers adjacent to each other, but separated by a thin brass

. . . details of the new column, and special problems involved in insulating low-temperature columns

wall. Details of plate construction are shown in Fig. 1. This arrangement has the effect of increasing the liquid path on the plate for better vapor-liquid contact which may slightly increase the plate efficiency. Since liquid hydrogen has a low viscosity, no flow difficulty is anticipated from this modified plate layout.

The feed to the column is essentially saturated vapor. If the bottoms product is close to zero, as in this case, and for an external reflux ratio of 2.0, a material balance around the feed plate and an over-all material balance around the column yields the following information:

$\overline{L} = L$, $L = 2F$, $\overline{V} = 2F$, *and* $V = 3F$

where the bar ($-$) superscript refers to the stripping section of the column, and F, L, and V, refer to the feed, liquid, and vapor rates respectively. This information, together with the chosen vapor velocity of 0.216 ft./sec. and the density of hydrogen vapor at column conditions (1.3 atm. and 21.3°K.), yields a feed rate of 14.4 g. moles/min. This feed rate may be expressed in other forms, such as 11.4 cu.ft./min. at S.T.P. conditions or an equivalent heavy water production rate of approximately 45 lb. for an 8000-hr.yr.

The flow system of the column is presented schematically in Fig. 2 and may be considered to consist of three separate parts. These are the circulation system, the condenser system, and the feed system. Fig. 3 shows the experimental setup of the flow system while Figs. 4 and 5 present two different views of the column with the vacuum-jacket removed. Only part of the radiation shield is shown in place.

The purpose of the circulation system is to provide the necessary boil-up at the bottom and a portion of the reflux at the top. This system consists of a reboiler, circulation pump, heat exchanger, and expansion valve.

The reboiler must supply heat to boil up the vapor, $\overline{V}$, of the stripping section which in the pilot column amounts to 434 w. (approximately 25 B.t.u./min.). Since this quantity of heat is rather large in terms of liquid hydrogen consumption, it is advisable to use a condensing vapor to achieve maximum heat transfer. Hydrogen is the obvious medium in this cycle.

Gaseous hydrogen is removed from the top of the column and passed through a countercurrent heat exchanger so that a circulation pump at room temperature may compress the gas to about 4 atm. The compressed gas is then cooled through the same countercurrent heat exchanger and passed through another heat exchanger in the reboiler of the column. In the latter heat exchanger the gas is condensed since it is at a higher pressure and consequently at a higher temperature than the column. The heat given up by the condensing gas provides the required boil up in the reboiler. The condensed liquid is then allowed to expand to 1.3 atm. through an expansion valve causing partial vaporization. The liquid fraction serves as a major portion of the reflux in the column.

The condenser system provides the remainder of the reflux and consists of a finned heat exchanger and a reservoir or heat sink of liquid hydrogen which vaporizes under atmospheric pressure as reflux is condensed. Both the condenser and reboiler are similar in construction. In each case, concentric rings of E.T.P. copper, 2⅝ in. in depth, form fins on the vapor side to provide additional area for heat transfer. One set of these fins is shown in Fig. 6. The liquid-hydrogen reservoir is kept filled automatically by employing a resistance-type liquid-level sensing device and a solenoid valve on the transfer line. Since liquid hydrogen at a Boulder atmosphere of 630 mm.Hg boils at 19.7°K. and the reflux condenses at 21.3°K., a temperature difference of 1.6°K. (2.88°F.) is available for heat transfer. Over-all heat transfer coefficients for the design of both the condenser and reboiler are shown in Fig. 7.

The feed system assumes that pure hydrogen gas is available as the feed and consequently no extensive purification system is indicated. In practice, feed would come continuously to the column from an outside source and be separated into product and distillate. In this column, however, the bottoms product and distillate are joined together and recirculated to the column as feed. In other words, once the column has been charged, the feed system constitutes a closed circulating system no feed need be added.

Components making up the feed system include a countercurrent heat exchanger, flow meters, an analyzer, and a circulation pump. The countercurrent heat exchanger warms up the product and distillate streams so that they may be handled by a circulating pump operating at room temperature. Once the two streams have been mixed and compressed to constitute feed to the column, the feed stream is cooled down in the same heat exchanger to near saturation temperature and then fed to the column.

An analysis system of the thermal conductivity type is similar to the one described by Weitzel and White (13) except for greater sensitivity. With analysis and flow information, material and heat balances can be made around the column.

Special problems

The insulation of low-temperature distillation columns poses an interesting problem. In high-temperature columns, heat loss is away from the column and has the effect of increasing the internal reflux and the size of the reboiler. In low-temperature columns the effect is just the opposite. Internal reflux and hence the separation are decreased. Refrigeration duty, always expensive, is increased. As a result, the equipment is built as compactly as

Figure 6. Condenser details. Fins of concentric rings of ETP copper.

possible to minimize heat leak. The cold components are squeezed inside a "cold box."

Consideration of the various modes of heat transfer to the cold box is suggested. Heat transfer by gaseous conduction is reduced to a negligble value by enclosing all the cold parts in a high vacuum of the order of 10^{-5} to 10^{-7} mm.Hg. The vacuum is maintained by continuous pumping of the cold box. Conduction through solids is made small by designing necessary supports in the form of long, low-conductivity heat leak paths. This is accomplished in the pilot plant by suspending all the cold parts inside the vacuum space from a stainless steel tripod supported on the bottom plate.

Heat transfer by radiation must be met by another approach. The column itself is surrounded by a thin copper sheeting attached to the hydrogen reservoir. Because of its high thermal conductivity this shield is maintained at essentially the temperature of the column. Consequently a negligible amount of heat is radiated to the column from this shield. To reduce the heat load impinging on this shield and hence to reduce the hydrogen boil-off rate from the reservoir, this shield is in turn surrounded by a liquid nitrogen cooled shield which absorbs the bulk of the radiation. The path of radiation then is from the vacuum can at 300°K. to a shield at 77°K. and finally to another shield at 20°K.

The amount of heat leaking to the column by radiation can be estimated by relying on the experience with existing large liquid-hydrogen dewars. The dewars consist of three concentric shells with alternate spaces evacuated. The inner sphere holds the liquid hydrogen, the first shell is high vacuum; the second is maintained at 77°K. by liquid nitrogen, and the third is again high vacuum between the liquid nitrogen and room temperature. Measurements made on these dewars (37) indicate the following heat transfer coefficients:

a) to the surface at 20°K.— 4×10^{-5} w./sq. cm.

b) to the surface at 77°K— 2×10^{-3} w./sq. cm.

When the same type of insulation for the column is assumed and the coefficients given above are used, the heat leaking to the hydrogen shield is about 1.3w. and the heat leaking to the nitrogen-cooled shield is approximately 92w. Thus the heat leak by radiation to the column itself is virtually eliminated.

A more complete discussion of low-temperature insulation and vacuum techniques is given by Scott (38).

In the design and construction of low-temperature equipment it is necessary to keep in mind the changes in length which will occur during periods of cool-down or warm-up. Some parts of the pilot plant, including the column itself, will change length by about half an inch in going from room temperature to 20°K. or vice versa. If both ends of such a member are rigidly fixed, the member will either buckle or fail, and the strain on solder joints which must remain high vacuum tight can be dangerous, to say the least. Short sections of bellows soldered into one end of a line can be used to alleviate such strains. Another artifice which can be used in a small diameter line is a loop or a couple of bends which places a short section of the line at right angles to the principal axis.

The column of the pilot plant is suspended from a tripod within the vacuum space with the bottom free to move up and down with changes of temperature. Three slender tie rods between condenser and reboiler help to relieve strain on the solder which joins together the individual plates.

Extreme caution must be exercised in the purity of the hydrogen mixtures to be distilled. Small impurities can quickly cut down the effectiveness of the separation. Plugging of the perforated and screen plates was observed directly in the one-plate column. The impurities generally were deposited on the wall of the column first in the form of a scale. However, with time this loose scale would flake off and fall on the plate where it would immediately cut down the active surface of the plate. If sufficient impurity were present, the plate was soon completely clogged and the distillation process ceased. To effectively eliminate such plugging, efficient traps of silica gel in liquid-nitrogen baths were used in all succeeding experiments. These require periodic regeneration. In commercial installations build-up of impurities may be inevitable and could require occasional shutdowns.

The safety aspects of handling liquid and gaseous hydrogen are another problem encountered in this particular low-temperature process. Under normal conditions hydrogen is a colorless, odorless, nontoxic gas. When mixed in the proper proportions with air, oxygen, or other oxidizers, it forms a highly flammable mixture. In air, the explosive limits for normal hydrogen are 4.1 to 74.2% by volume (*39*, *40*). Ignition of hydrogen-air mixtures takes place with extremely low-energy input; an invisible spark can cause an explosion. Hydrogen liquid is at least as hazardous as the gas since, due to evaporation, some gas is always present and a large quantity is instantly formed if liquid is spilled.

Because of the hazardous nature of hydrogen, many safety features were incorporated into the design of the pilot plant. All electrical switches and motors are explosion-proof. All electronic equipment that is not sealed is constantly purged with inert nitrogen gas and all equipment is individually grounded. The column has been placed in a well-ventilated room. Exhaust hydrogen is either piped to a gas holder outside the building or vented above the roof. Equipment is purged with an inert gas and evacuated before adding hydrogen and purged with an inert gas after removing the hydrogen. No open flames are allowed and only nonsparking tools should be used in the room when hydrogen is being handled. In addition, static build-up is carefully avoided by the use of conducting floors and shoes. It has also been found that use of commercially available antistatic sprays on clothing, chairs, etc., materially reduces the likelihood of collecting high static potentials.

Figure 1. Construction details of pilot plant screen plates.

Preliminary Considerations for The New Column

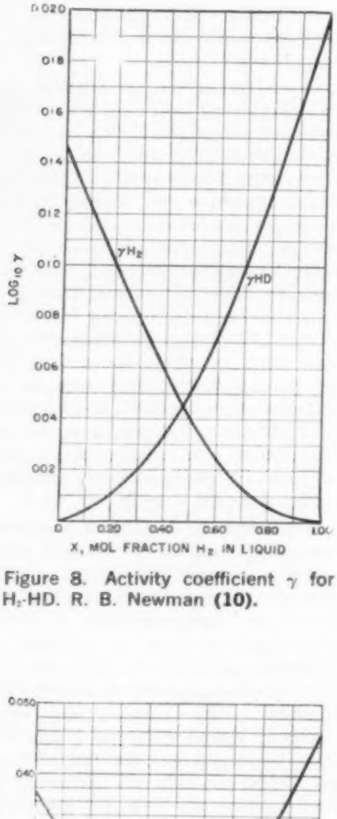


Figure 8. Activity coefficient γ for H_2-HD. R. B. Newman **(10)**.

Although the heavy hydrogen isotope was discovered *(1)* in 1931, it was not until eight years later that Brickwedde and Scott (*2*) used fractional distillation to separate H_2, HD, and deuterium. Later Clusius and Starke (*3*) advocated this method for the production of heavy water. The latter used a wetted-wall spiral-glass column equivalent to about five theoretical plates. Liquid hydrogen was not only used as the condenser coolant, but also to surround the whole vacuum jacketed unit. This method is now generally used in the preparation of pure HD (*4*).

Before proceeding with any distillation discussion it is necessary to consider the *ortho-para* forms of hydrogen and deuterium and the existing equilibrium relationships for the two systems H_2 - D_2 and H_2 - HD.

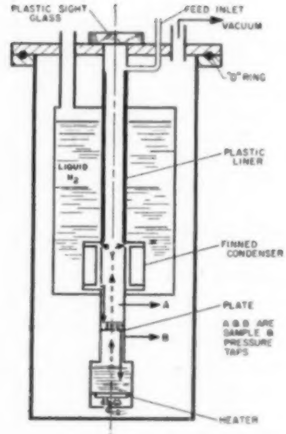


Figure 12. One-plate still.

Because of the quantum-mechanical effects associated with nuclear spin, hydrogen and deuterium each exist in *ortho* and *para* forms (*5*) each of which exert different vapor pressures at the same temperature (*6*). Hydrogen deuteride, which is not formed from identical nuclei, does not possess such modifications.

Normal hydrogen (n - H_2) at room temperatures is 25.08% parahydrogen (*6*) which closely approaches the high temperature composition limit of 25.00% para. The equilibrium composition at the one atmosphere liquefaction temperature of 20.39°K. is 99.79% para (*6*). In the absence of catalysts, liquefied normal H_2 will un-

Table I. Effect of Nonideality of the H_2-D_2 System on the Vapor-Liquid Equilibrium at 760mm. Hg.

x	γH_2	γD_2	$\gamma H_2/\gamma D_2$	$\alpha^\circ H_2/D_2$	$\alpha H_2/D_2$	y°	y
0	1.090	1.000	1.090	2.32	2.53	0	0
0.10	1.074	1.001	1.073	2.38	2.55	0.209	0.221
0.20	1.059	1.003	1.055	2.46	2.60	0.381	0.394
0.30	1.045	1.009	1.036	2.51	2.60	0.521	0.527
0.40	1.033	1.015	1.017	2.58	2.62	0.632	0.636
0.50	1.022	1.025	0.997	2.66	2.65	0.727	0.726
0.60	1.014	1.037	0.978	2.69	2.63	0.800	0.798
0.70	1.008	1.052	0.956	2.74	2.62	0.865	0.859
0.80	1.003	1.071	0.937	2.85	2.67	0.923	0.915
0.90	1.001	1.088	0.920	2.88	2.67	0.963	0.960
1.00	1.000	1.111	0.901	2.97	2.67	1.000	1.000

where

x = mole fraction H_2 in the liquid phase

γH_2 = activity coefficient of H_2

γD_2 = activity coefficient of D_2

$\alpha^\circ H_2/D_2$ = relative volatility of H_2 to D_2 calculated with the assumption of ideal solutions

$\alpha H_2/D_2$ = true relative volatility of H_2 to D_2

y° = mole fraction of H_2 in the vapor phase calculated with the assumption of ideal solutions

y = actual mole fraction of H_2 in the vapor phase calculated with Newman's activity coefficients.

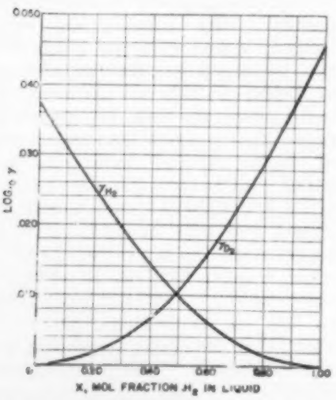


Figure 9. Activity coefficient γ for H_2-D_2. Newman **(10)**.

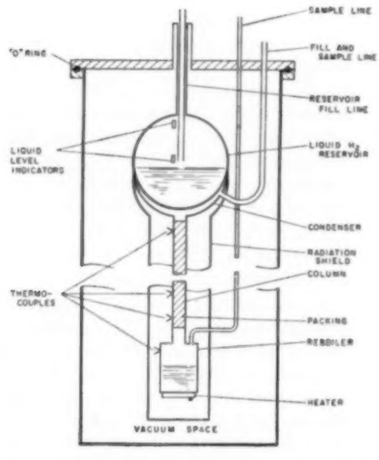


Figure 10. Packed distillation column.

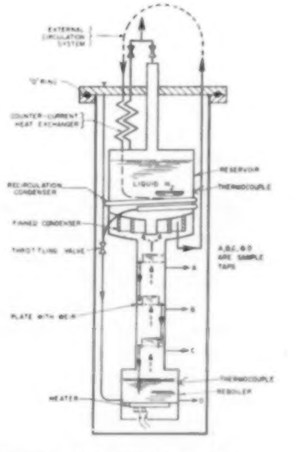


Figure 13. Multiple-plate still.

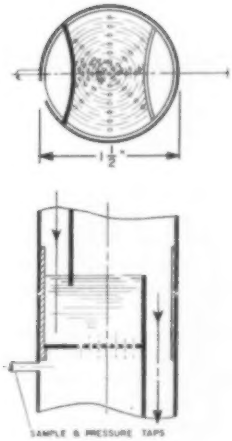


Figure 14. Perforated plate.

dergo a slow ortho-to-para conversion. This exothermic *(6)* conversion to the new equilibrium is second order in the ortho-concentration with an internal conversion rate constant of 0.0114/hr. when concentrations are expressed in mole fractions.

Normal deuterium at room temperature is 66.6% o - D_2 while the liquid equilibrium composition at 23.57°K. is 96.24% o - D_2. The self-conversion of nonequilibrium mixtures of o - and p - D_2 also proceeds at a slow rate. Because of the slow self-conversion rate for either the hydrogen or deuterium mixtures, this study is essentially concerned with distilling liquefied normal hydrogen and normal deuterium.

Vapor - pressure relationships for liquid hydrogen are available as equations of the type:

$$\log P^\circ = A + \frac{B}{T} + \ldots \tag{1}$$

and hence the relative volatility, α°_{12}, between components 1 and 2 assuming the validity of Raoult's and Dalton's Law may be obtained by difference between two corresponding equations as:

$$\log \alpha^\circ_{12} = \log \frac{P^\circ_1}{P^\circ_2} = (A_1 - A_2) + \frac{(B_1 - B_2)}{T} + \ldots \tag{2}$$

From the data of Brickwedde, Scott, and Woolley *(6)* the equations for relative volatilities are:

$$\log \alpha^\circ_{H_2 - HD} = -0.38277 + \frac{10.2926}{T} + 5.747 \times 10^{-3}\, T \tag{3a}$$

$$\log \alpha^\circ_{H_2 - D_2} = -0.0643 + \frac{13.5050}{T} - 6.17 \times 10^{-3}\, T \tag{3b}$$

Similar relationships are available from other published data (7, 8, 9).

In the case of nonideality of the liquid, an activity coefficient γ, is introduced into the vapor-liquid equilibrium relationship. Recent experimental work by Newman *(10)* gives the activity coefficients for the binary systems H_2 — HD and H_2 — D_2. These are shown on Figures 8 and 9 for a pressure of one atmosphere and were used to calculate the actual $x - y$ equilibrium diagrams for the same two systems. It is interesting to compare the vapor-liquid equilibrium data calculated with the assumption of ideal solutions with those calculated with the aid of Newman's activity coefficients. Such a comparison is made in Table 1.

Since the relative volatility increases with a decrease in operating temperature, the distillation separation becomes easier under conditions of reduced pressure. However, the advantage of vacuum distillation is doubtful at this time since the size of the plant would be increased and possible leakage of air into the distillation column would present an additional hazard and complication.

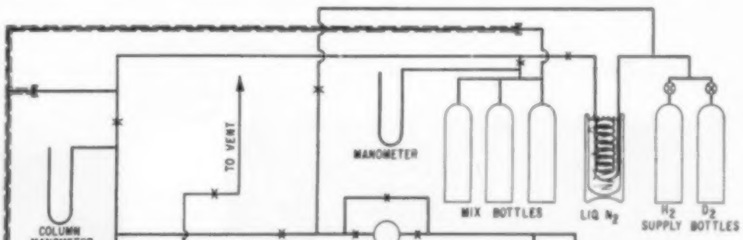


Figure 11. Flow system for experimental columns.

Details of Design Data

Because of the scarcity of published capacity and performance data for low-temperature distillation columns, most of the detailed column design at present is carried out in the same manner as it is for high-temperature columns. Some factors considered in such a design include the maximum or allowable vapor capacity, pressure drop of vapor passing through the plate, liquid-flow resistance across the plate and through the downcomers, plate efficiency, weir height, plate spacing, and minimum vapor and liquid loadings required for effective contacting. If packed columns are considered, additional information in height equivalent to a theoretical plate (HETP), pressure drop, and holdup are of importance. In addition, heat transfer coefficients are desirable for design of the reboiler and condenser surface areas.

The usual approach to limiting vapor load in the design of columns is based on the maximum allowable vapor velocity, which in turn depends upon the allowable pressure drop in the column, entrainment, and the decrease in the plate efficiency. The behavior has been derived *(14, 15, 16)* on a theoretical basis by equating the frictional upward pull of vapor upon a suspended liquid droplet to the downward gravitational force on this same particle in the following relation:

$$U_m = K_v \left(\frac{\rho_1}{\rho_v} - 1\right)^{1/2} \qquad (4)$$

where U_m is the limiting linear vapor velocity and ρ_1 and ρ_v refer to the liquid and vapor densities respectively. For a given column size K_v is an empirical constant and varies with surface tension. In the theoretical derivation K_v depends upon the droplet diameter, while the viscosity is assumed to have no effect.

For the experimental packed column used in early studies (Figure 10), feed charges of 50-50 H_2-D_2 mixtures were used to measure the maximum throughput of the column under total reflux conditions. [See also flow diagram (Figure 11) applicable to both packed and plate column systems.] Since this column (and succeeding columns) was surrounded with a hydrogen radiation shield in all experimental runs, the heat leak past the shield to the column was measured and found to be negligible. These adiabatic conditions made possible the direct evaluation of the vapor velocity in the column from reboiler heat input. To determine vapor loads in the column, the heat input to the reboiler was increased until flooding or unstable operation occurred. The approach to this throughput for the packed column was observed in two ways:

1) A modified helium leak detector was connected to the condenser space of the column and samples of the gas in the condenser analyzed continuously. Under unstable conditions the concentration of D_2 in the condenser increased sharply.

2) The temperature profile along the column was observed by means of Cu-AuCo thermocouples *(11, 12)*. During stable operation the local temperatures remained steady, as contrasted to definite fluctuations caused by large concentration gradients under unstable conditions.

The maximum throughput in the 30-in.-long packed column under total reflux and 1 atm. was obtained with a superficial vapor velocity of approximately 2.5 in./sec. This number was not very reproducible and measurements with the 10-in.-long column, for example, indicated a maximum throughput of only 1.7 in./sec.

In the one-plate column also used experimentally (Fig. 12) flooding or pile-up of liquid on the plate could be observed through a clear plastic window at the top of the still. This flooding at the lower throughputs was not a function of the free area of the plate, i.e., the area of the holes on the plate, but rather depended upon the downcomer area. The latter dependence is not readily predicted from higher boiling fractions *(14)*. This same phenomenon has been observed by other workers *(17, 18)*. As a result, the downcomer cross-sectional area was increased stepwise from 12 sq. mm. to 90 sq. mm. and the behavior of the column observed after each increase. Only after this approximate eightfold increase did the downspout area cease to be the limiting factor.

Liquid pile-up occurred on the perforated plates at lower throughputs than it did for the sieve plate. The sieve plates had approximately square holes while the perforated plates had round holes. Although no real conclusion can be drawn, it may be noted that the geometry of the hole influences the height of liquid which can be held above the plate by surface tension.

Once the downcomer area had been eliminated as the limiting factor, the column could not be made to flood when sieve plates were employed

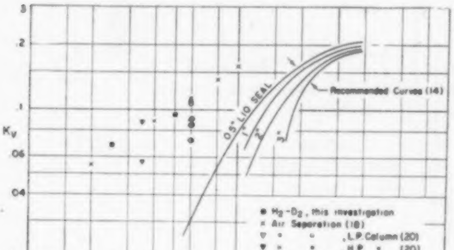


Figure 15. Maximum allowable vapor velocity for various low-temperature distillation columns.

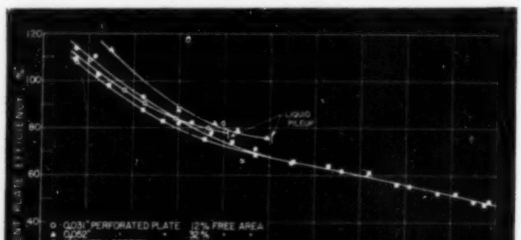


Figure 16. Over-all plate efficiency, plate variable. Values for conditions of total reflux in a one plate column, 1½-in. diam., 3/16 in. weir, and 90 sq. mm. downspout.

even at the maximum throughput available. This throughput in the plate column corresponded to about 15 in./second vapor velocity. No significant difference was observed in the vapor-liquid behavior for the different mesh screens employed, that is, a 40-mesh and a 100-mesh screen performed about equally well.

Foaming similar to that described by Linde *(19)* for N_2 concentrations between 20 and 90% in either O_2 or *A* was not observed for the H_2-D_2 system over the D_2 concentration range between 10 and 60%. On the contrary, the system is very clean boiling. However, through use of a movable sample tap, definite signs of entrainment were noted when the sample for analysis was obtained directly above the liquid on the plate. Entrainment ceased to be a problem at vapor velocities of 15 in./sec. or less when the sample tap was raised approximately 2½ in. above the liquid level. Accordingly the experiments with the multiplate still (Figs. 13, 14) used plate spacings no smaller than 2½ in.

Maximum throughput for the multiplate column could be followed in three ways: (1) by thermocouples attached to the column, (2) by the analysis system, and (3) by observing the pressure in the column. When the column became flooded, no further separation occurred. At this point, the temperatures of the condenser and the boiler were essentially the same. If only a section of the column flooded, the analysis system would indicate no concentration gradient within that section. Also, as D_2 enriched material moved up to the colder part of the column, the vapor pressure within the column was observed to drop sharply.

The heat supplied to the reboiler to cause flooding could be determined rather accurately. However, since sample taps were not available on every plate, only an approximate vapor velocity could be calculated because of the existence of a concentration gradient in the column. For this reason, the approximate vapor velocities indicated in this paper are based on the density of pure hydrogen at column conditions, and hence approximate the actual vapor velocity at the top of the column. Furthermore, these approximate vapor velocities are based on the total cross section of the column, assuming no downspouts to be present.

. . . the overall efficiency is defined as the ratio between the number of theoretical plates and the number of actual plates for a given separation.

Published data *(14, 17, 20, 21)* on the capacity of low-temperature columns are compared in Figure 15 with results obtained in this investigation. The plot shows K_v as a function of plate spacing. Only two points for the H_2-D_2 system are shown (one for 2½ in. and the other for 5-in. plate spacing) because these most closely approach the conditions of other investigators. The represented points are for a 1½-in. diam. perforated plate column having .031-in. diam. perforations and 12% free area. Other runs made with plates having .052-in. diam. perforations and 40- to 100-mesh screens, all having free areas much greater than 12%, indicate that still greater vapor flows may be handled. In fact, K_v values as high as .114 for the 2½-in. plate spacing have been obtained with screen plates for the multiplate column. Effects of liquid seal on the allowable column vapor velocity were noted to be similar to those experienced for higher boiling fractions *(14)*.

Over-all Efficiency

There are several ways of defining distillation efficiency, and several relationships exist between the quantities defined.

Unless otherwise stated, all mole fractions are given in terms of the light isotope. Complete mixing of the vapor and steady-state conditions are assumed to prevail. The relative volatility of the light to the heavy isotope is represented by α.

The over-all efficiency, E_o *(14)*, is defined as the ratio between the number of theoretical plates and the number of actual plates for a given separation. By definition, a theoretical plate is one on which the vapor leaving the plate is in equilibrium with the liquid flowing down from the plate. Hence, if the liquid were completely mixed on the plate, it would be impossible to obtain a better separation than that given by a theoretical plate. For steady-state distillation at total reflux, the Fenske *(22)* or Underwood *(23)* equation may be employed to calculate E_o:

$$E_o = \frac{\log(y_1/y_2)\ n' \quad (y_2/y_1)\ n''}{(n'' - n')\ \log \alpha_{12}} \tag{5}$$

where suffixes 1 and 2 denote the components in the vapor-phase mole fractions, y, at the positions n' and n'' in the column. When $y_2 >> y_1$, and approaches unity as in the case of isotope systems, then dropping the suffixes of Equation (5) and allowing y to represent the dilute component result in:

$$E_o = \frac{\log\ (y_n'/y_n'')}{(n'' - n')\ \log \alpha_{12}} \tag{6}$$

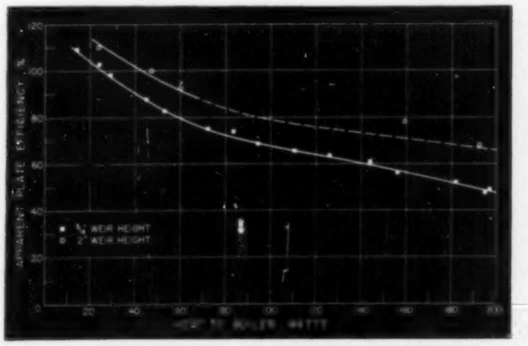


Figure 17. Over-all plate efficiency, weir height variable. Values for conditions of total reflux in a one-plate column, 1½-in. diam., with 40-mesh screen with a 90 sq. mm. downspout.

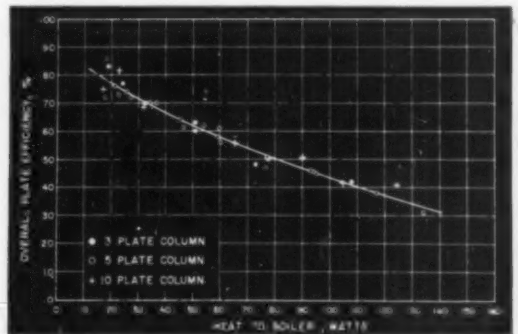


Figure 18. Over-all plate efficiency, number of plates variable. Values for conditions of total reflux in a 1½-in. diam., column with 40-mesh screens spaced 2½ in. apart and with 90 sq. mm. downspout.

Design data

continued

For the general case, a ratio of the theoretical plates, required to effect a given separation as evaluated by the McCabe-Thiele *(24)* method to the actual number of plates needed for the same separation, determines the over-all efficiency.

Values of over-all plate efficiencies may exceed 100% if a concentration gradient exists across a plate allowing the vapor actually leaving the plate to have a larger fraction of the more volatile component than the vapor in equilibrium with the liquid leaving the plate. This effect of concentration gradient has been studied by several investigators *(7, 10, 25, 26)*. Because of the small diameter column used in this investigation and the intense agitation observed on the plates, the assumption of negligible concentration gradient across the plate is felt to be valid.

End effects about terminal plates or wetted-wall effects within the column also may give rise to over-all efficiencies greater than 100%.

Several other plate efficiencies have been proposed *(27, 28, 29)* but the most commonly used is the over-all plate efficiency, E_o, as defined above. This factor, by which the number of theoretical plates must be divided to give the actual number of plates, has no fundamental mass transfer basis but it serves as an easily applied and useful design parameter.

The usual equations for predicting distillation efficiencies fail when applied to the hydrogen system, for the bulk of the data for efficiency correlations is obtained with hydrocarbon or alcohol systems having a viscosity, μ, in the range of 0.07 to 1.4 centipoise. For liquid hydrogen at 20.5°K, the viscosity has a value of 0.0136 centipoise *(30)*. Thus the relationship given by Drickamer and Bradford *(31)*

$$E_o = (0.17 - 0.616 \log \mu)\ 100 \qquad (7)$$

yields the value

$$E_o = 131\%.$$

A similar relationship, given by O'Connell *(32)* gives E_o of 120%.

These and other correlations for predicting efficiencies are generally applicable only to systems having physical characteristics similar to those for which the data were obtained. The unusual characteristics of the hydrogen system, low viscosity, extremely low boiling point, etc., make it appear unlikely that the correlations published to date would be suitable here for predicting efficiencies.

Although the system studied consisted of hydrogen and deuterium, it was possible that hydrogen deuteride was being formed in the still. This would, of course, upset the analysis because the analyzer was calibrated for only H_2-D_2. Samples for mass spectrometer analysis were taken concurrently with those sent through the thermal conductivity apparatus and compared. The mass spectrometer analysis showed no HD present and confirmed the results of the thermal conductivity analysis.

Measurement of the HETP (height equivalent to one theroretical plate) for the packed column proved to be somewhat difficult. Since the efficiency of the packing was high and the limitations of the analysis system known, the length of the column was cut down first to 10 and later to 5 in. The shortest column permitted a fair approximation of the HETP. For throughputs of approximately 50% of maximum, the HETP for this particular packing was slightly greater than ½ in. Later experiments with the same packing and another column established the more accurate value of ⅜ in. under the same throughput conditions. This value for the HETP is approximately the same as that obtained when the packing is used for separation of test mixtures of much higher boiling points.

Apparent plate efficiency for the one-plate column was measured first as a function of throughput. This is shown in Figure 16 for two perforated plates and two screen plates. Since liquid pileup and hence unstable operation of the column occurred at lower throughputs for the perforated plates than pileup did for the screen plates, the experiments with the screen plates cover a wider range of throughput than do the perforated plates. The 40-mesh and 100-mesh screens gave essentially identical values of plate efficiency at high throughputs, and gave only slightly different values for efficiency at the lower throughputs.

Unrealistic high values of plate efficiency were obtained for this one-plate still at the lower throughputs. This could be attributed either to end effects within the column or to a failure of the thermal conductivity analysis system. A mass spectrometer was used to check the analysis system with a favorable comparison resulting. It can then be concluded that the wetted-wall effect of the column and other effects around the single plate helped increase the separation obtained with the column.

Weir heights were varied from a minimum 3/16 in. to a maximum of 2 in. It was observed that the latter weir height gave a slightly higher efficiency at a given throughput. This effect can be seen in Figure 17. The increase is insignificant, however, when one considers the disadvantage of large liquid holdup with the use of high weirs. Because of this, the 3/16-in. weir was used for most of

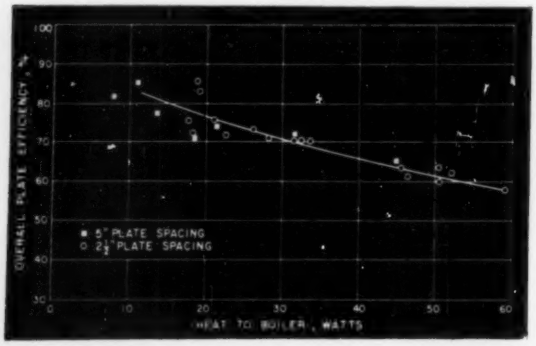


Figure 19. Over-all plate efficiency, plate spacing variable. Values for conditions of total reflux in a 1½-in. diam. column with 40-mesh screens with ¾ in. weir height and 90 sq. mm. downspout.

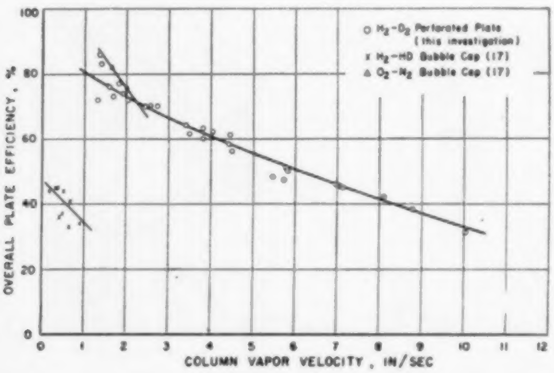


Figure 20. Comparison of over-all efficiencies for various systems.

the one-plate runs.

Figure 18 represents the data obtained for over-all plate efficiency at total reflux for the three,-five,-and ten-plate columns. This curve represents the efficiency for the center-section plates which were not influenced by end effects.

Data represented by Figure 18 were taken over a period of about four months during which time the charge to the still was varied from 10 to 60% D_2 in H_2. There is good agreement among the data, as can be seen from the curve, and it is felt that this curve represents rather well an over-all plate efficiency free from end effects for the range of concentrations studied.

To determine the order of magnitude of the wetted-wall effect, a column was constructed identical to the five-plate column but without plates, downcomers, or other column internals. The sample taps were placed approximately where they would have been had there been plates in the column. The column was then operated under the same conditions as if plate efficiencies were to be determined, and an HETP calculated for the wetted-wall column. These experiments gave an HETP of approximately 6 in. for this wetted-wall column.

No attempt should be made to correlate the HETP obtained with this wetted-wall column to the column operating with plates and downcomers in place. In the former case, the liquid returning from the condenser is free to wet the walls of the column and to contact the vapor rising up the column. In the latter case, the largest part of the liquid flows down the column by means of the downspout and is *not* in contact with the ascending vapors except on the plate itself. The HETP obtained with the wetted-wall column is not applicable to the plate column, but gives an idea of the separation that could be obtained with modifications of this type column.

The effect of plate spacing with the three-plate column was determined by using perforated plates and a 12-sq. mm. downspout. This small downspout limited the throughput of the column to values somewhat lower than were obtained with the screen plates. However, it is evident from Figure 19 that there is no significant difference in the performance of the column for the two-plate spacings used, 2½ in. and 5 in. Since the smaller plate spacing means a shorter column for a given number of plates, all the later experiments were conducted with a 2½-in. plate spacing.

It is of interest to compare these over-all efficiencies with results obtained by other investigators for various low-temperature systems. The work of Sellers and Augood *(17)* has already been mentioned. They report the results of O_2-N_2 and H_2-HD separations with a 27-mm. diam. glass column with a single bubble cap on each tray. For the O_2-N_2 system over-all plate efficiencies varied from 76-82% for a throughput range of 50-80% of maximum and a 1.37-3.84 cm. liquid seal. Increase of the liquid seal affected the efficiencies by approximately 5%. This agrees with the findings here, namely that greater liquid seal results in only a small increase in efficiency. Over-all efficiencies for the H_2-HD system with the same glass column were much lower, averaging between 35-44%. Latimer reports on the O_2-N_2 separation using a single 8-in. diam. sieve plate with radial liquid flow having 0.9-mm. perforations on 3.2-mm. triangular centers. Efficiencies varied between 70 and 100%, being greatest at concentrations where foaming was observed. The present authors' results and the work of other investigators are shown on Figure 20.

Aside from these studies the selection of a realistic tray efficiency has been made by relying on previous experience and inferences drawn from high-temperature distillation. Usually this experience has come from knowing that an air-separation plant in which 65% tray efficiencies were used for design purposes operated satisfactorily *(33)*.

Other Parameters

Pressure drop measurements across the perforated plate were quite difficult because of the small pressure fluctuation continually present in the column. However, it was established that the pressure drop across the screen plates during operation was of the order of 1.5 mm. H_2O for a weir height of ⅜ in. The dry pressure drop

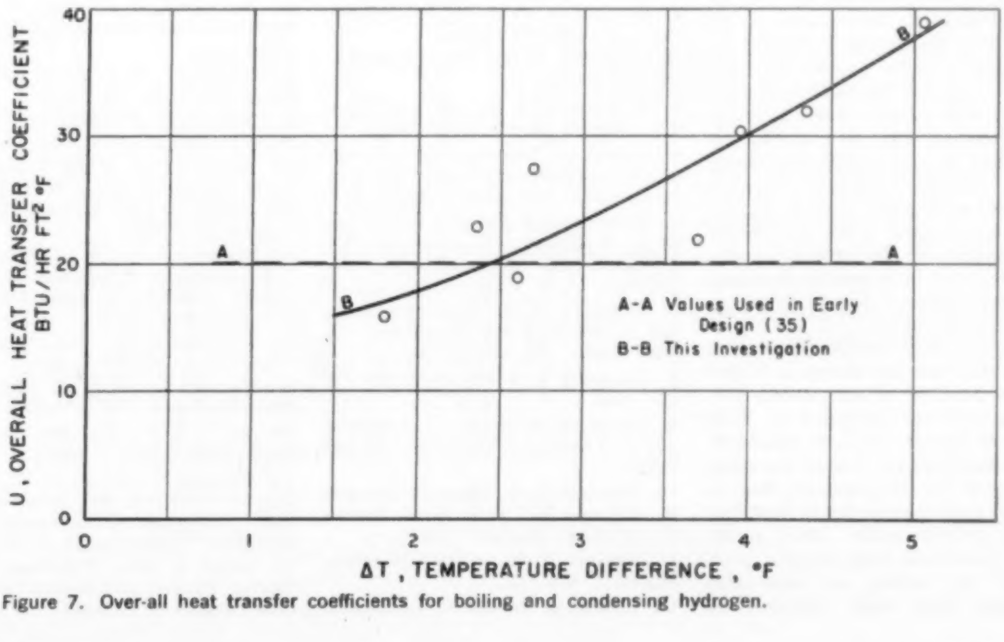


Figure 7. Over-all heat transfer coefficients for boiling and condensing hydrogen.

Design data

continued

was negligible even for the 10-plate column.

Generally, a well-designed sieve tray will weep at about one third of its maximum vapor flow rate. This gives an adequate operating range. Unfortunately no information was obtained on the lower operating limits of either the perforated or the screen plates other than that no apparent weeping was visible in the one-plate column even at zero heat input to the reboiler. In other words, the small heat leak to the column was still large enough to maintain normal conditions on the plate. The low density of the hydrogen liquid certainly must be a factor here.

Another factor necessary in the design of a hydrogen distillation column is the expected over-all heat transfer coefficient as a function of the temperature difference for condensing and boiling hydrogen. This is of concern in both the condenser and the reboiler. Consequently heat transfer measurements were made on the condenser of the multiplate column. Condensing surface in the condenser was provided by a series of concentric rings made of "electrolytic tough pitch" (ETP) copper. The latter was selected because of its relatively higher thermal conductivity at liquid-hydrogen temperatures as compared to other commercial coppers *(34)*. This reduced the temperature gradient in the fins to a negligible value resulting in a condensing surface of essentially constant temperature. The temperature of the condensing vapors was controlled by the pressure in the column and condensate was directly related to heat input in the column since the entire operation was conducted at total reflux. Thus as long as the condensing surface was not limiting and flooding did not occur, the boil-up in the column was equal to the condensate. Vaporization of the constant temperature liquid hydrogen in the reservoir was measured directly by means of a wet test meter.

Over-all heat transfer coefficients from these tests are shown in Figure 7 as a function of temperature difference and are compared to those given by Murphy *(35)*. It should be emphasized that no attempt was made to remove the copper-oxide film on the fins since interest lay in how they would perform under actual conditions. Individual heat transfer coefficients for boiling or condensing hydrogen have been reported by Brickwedde *(1)* and naturally are much higher than the over-all coefficients.

Conclusions

The conclusions from this work are encouraging. Stable column operation is assured for quite a range of vapor velocities for the screen plates. This implies that an excessively large column diameter may not be required for a reasonable throughput. The latter is dictated by economic considerations relating the plate efficiency and vapor velocity in the column. The height of the column can also be kept to reasonable values because of the small plate spacing which is necessary. Another desirable feature is the small pressure drop of the column and the small holdup.

These factors have made possible the design and construction of the column of pilot plant size, operation of which is proceeding satisfactorily, and will be reported in a later communication.

Acknowledgment

The guidance and encouragement of P. C. Vander Arend during the early part of this study, and the assistance of J. W. Draper, O. E. Park, R. J. Devereux, and G. H. Wallace in the construction of equipment are gratefully acknowledged.*

* *Presently associated with Air Products, Inc.*

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Determining viscosity of Liquefied Gaseous Hydrocarbons at low temperatures and high pressures

The increasing importance of low temperature processing has created the need for more reliable data concerning the effects on materials under these conditions.

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University of Kansas, Lawrence, Kansas

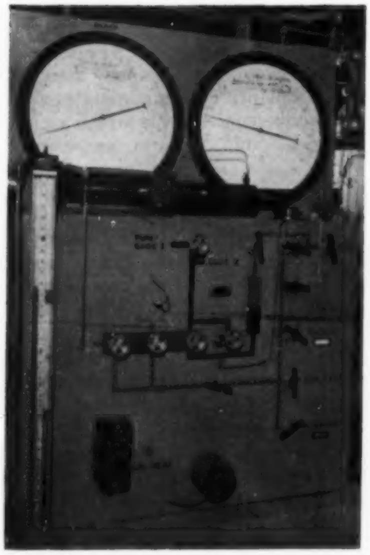

Figure 3. Exterior of constant temperature box.

IN RECENT YEARS the use of low temperature processing has increased, particularly in the petrochemical and natural gas industries. Accordingly, a greater need for appropriate data on the properties of materials at low temperatures has developed. Among the data needed are phase, volumetric, and viscous properties. In view of the dearth of low temperature data, the construction of apparatus for the determination of liquid viscosities of normally gaseous hydrocarbons seemed appropriate. An apparatus to secure these data was designed and constructed to operate over the following range of variables:

Temperature	−185° to 100°C.
Pressure	3mm.Hg abs. to 1,000 lb./sq. in. abs.
Viscosity	0.01 to 2.0 centipoises.

Operating the equipment within

[1] Now with Esso Standard Oil Company, Baton Rouge, Louisiana.
[2] Now with Dow Corning Corporation, Midland, Michigan.

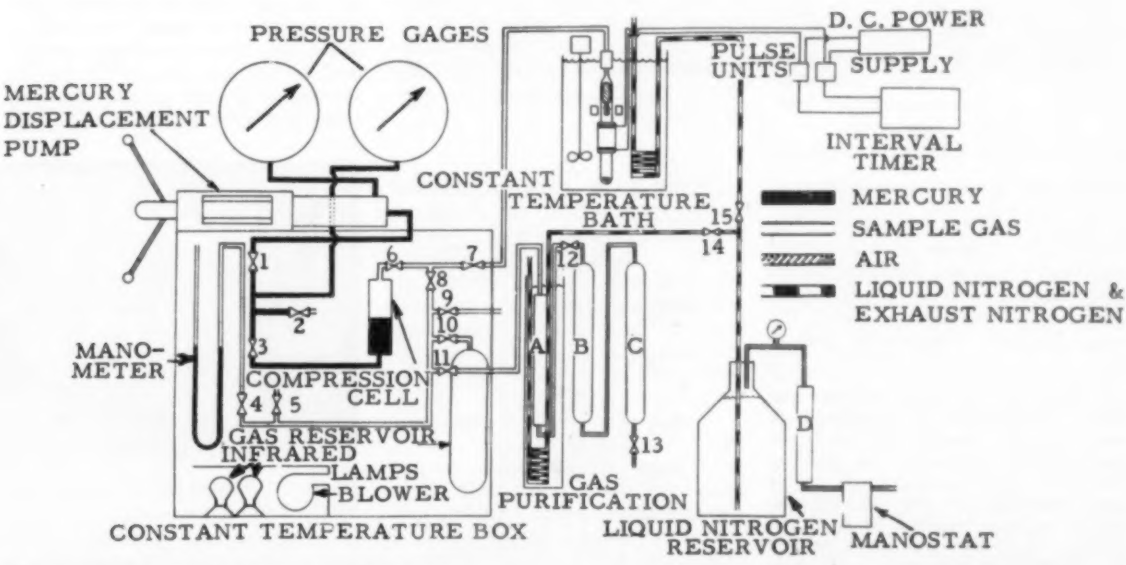

Figure 2. Schematic diagram of apparatus.

. . . unique features of the apparatus which set it apart from equipment used previously by other experimenters in the field—four functional units must be considered

these ranges, data may be obtained for

1. Pure components:
   a. Vapor and liquid densities
   b. Liquid viscosities
2. Mixtures:
   a. Phase equilibria
   b. Liquid and vapor densities
   c. Liquid viscosities
      (See Figure 1.)

The apparatus has the following unique features which set it apart from equipment used by other experimenters in the field:

1. Visual observation of the viscometer cell and its content is possible at all temperatures and pressures.

2. Phase and volumetric data may be taken on the same apparatus.

3. Equilibrium may be attained rapidly.

4. A falling body viscometer* is used, the falling body being cylindrical in shape with hemispherical ends. The design of the viscometer is such that laminar flow can be maintained over the range of variables thereby allowing accurate and rapid calibration.

5. Temperatures can be controlled to within $\pm 0.1°C$ over the operating range of temperature.

6. Sampling is not required for binary mixtures.

Apparatus

The apparatus may be considered in terms of four functional units:

The constant temperature box,
The gas purification equipment,
The constant temperature bath,
The auxiliary equipment.

This breakdown is shown in Figure 2.

Constant Temperature Box

The constant temperature box serves two purposes. It is a storage reservoir where gas mixtures can be made up and left to reach equilibrium at a temperature above the cricondentherm temperature, and it serves as a metering point for all sample gas that is sent to the viscometer cell. The volume of the equipment in the box is a known quantity, as is the volume of the displacement pump. This allows the calculation of the amount of sample gas present in the box and tubing at any time if compressibility data are determined or are known for the gas under study.

The tubing used for the pressure system in the constant temperature box is ⅛ inch stainless steel rated for 3000 psi working pressure.

The valves used in that portion of the pressure system containing mercury are stainless steel needle valves. The valves used in the balance of the pressure system are especially adapted Autoclave Engineers valves. Two bourdon tube gages are used to measure pressure: a 0-5000 psi gage, and a 0-2000 psi gage. A mercury displacement pump is used with a stainless steel pressure cell to compress and displace the sample gas. Figs. 3 and 4 are photographs of the exterior and interior of the constant temperature box.

Referring to Fig. 2, it will be seen that the pump and the pressure gages are filled with mercury. This is done:

a. To prevent condensation of gas samples in the pressure gages, since the gages cannot be kept at the elevated temperature of the constant temperature box.

b. To reduce the dead space in the bourdon tubes and around the pump piston thereby increasing the compression ratio.

c. To obtain more accurate volumetric readings with the displacement pump.

Two infrared lamps operate in conjunction with a temperature controller and centrifugal blower to maintain the constant temperature box at the desired preset temperature.

Gas Purification Equipment

The gases used in this research are Phillips Petroleum Company samples of 99 mol per cent minimum purity. To remove constitutents which would be undesirable for low temperature work, these samples were passed through an additional purification train.

Sample gas from the high pressure storage cylinder is first passed through a tube containing phosphoric anhydride to remove water, then through a sodium hydroxide suspension on silica gel to remove carbon dioxide, and then condensed in a cold trap packed with Linde 5A Molecular Sieve. The sieve adsorbs the light ends in the sample and the heavy ends were liquefied or frozen out. The vapor from the cold trap is used for viscosity determinations.

Constant Temperature Bath

The constant temperature bath, into which the viscometer cell is immersed, was designed to operate over the temperature range of $-185°$ to $100°C$. A schematic diagram of the bath is shown in Fig. 5. The bath is composed of two parts: the bath housing and the bath insert. The bath

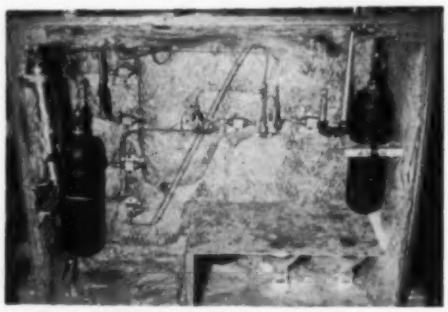

Figure 4. Interior of constant temperature box.

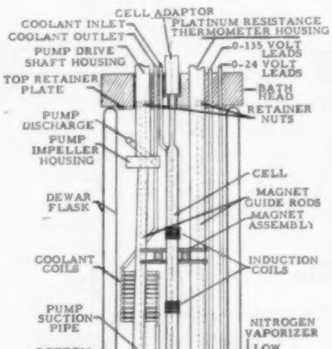

Figure 5. Schematic diagram of constant temperature bath.

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* Markwood (2), and McGowry and Mark (3) recommended the falling body viscometer for viscosities of fluids in the range of 0.01 centipoises. In addition, the falling body viscometer cell can be used interchangeably with an equilibrium cell of the type described by Kohn and Kurata (1), thereby providing a method for determining volumetric and phase data.

housing is a 5.6-liter Dewar flask which has two unsilvered strips diametrically opposed to allow observation of the bath interior and viscometer cell. This flask is mounted on a platform which may be moved vertically for rapid access to the bath insert.

The bath insert is a framework built to hold the equipment components that must be immersed in the bath. These components are:

1. Viscometer cell.
2. Cooling system.
3. Heating system.
4. Agitator pump.
5. Platinum resistance thermometer.
6. Magnet assembly.
7. Timing inductance coils.

The bath head is made of ¾ inch plywood and bolted to the bath insert framework. The bath head is covered with a layer of fiberglass insulation to reduce the heat leak into the bath.

The cooling system consists of: a coolant storage reservoir, a vaporizer which is located at the bottom of the bath insert, and a cooling coil through which the coolant passes after it leaves the vaporizer.

The coolant used for normal operation is liquid nitrogen. Air pressure on the coolant storage reservoir is used to drive the coolant through the system. The nitrogen gas leaving the cooling coils is exhausted to the atmosphere. Regulation of the coolant flow rate is accomplished by throttling the intake with a needle valve.

The cooling effect of the nitrogen is opposed by heat input from two heater units, giving more accurate temperature control. A small centrifugal type pump with an air motor drive is used to circulate the bath liquid to permit efficient operation of the heating and cooling systems. The pump intake is at the bottom of the bath, and the discharge is at the top. The pump assembly is suspended independently to eliminate vibration of the bath insert and the viscometer cell.

The bath insert has a built-in thermometer housing to protect the platinum resistance thermometer from shock and viscometer cell rupture during high pressure operation. It is also perforated to allow free circulation of bath liquid around the thermometer stem.

A "C" type magnet which is free to move vertically on two guide rods is provided to return the falling body to the drop position at the top of the cell. The magnet also provides a means for agitating the cell content. This facilitates the rapid attainment of equilibrium in the cell.

The time-interval meter measures the time required by the falling body to traverse the distance between two timing inductance coils. These coils are mounted a fixed distance apart on the outside of the viscometer cell. Eight turns of 0.025 inch enamel covered magnet wire is used for each coil winding. Coaxial cable leads are soldered to the coil wires and extend through the bath head to the timer pulse units.

The viscometer cell is made from Fish-Schurman precision bore pyrex tubing with one end welded closed. The tolerance on the inside diameter of this tubing is ± 0.0005 in. Before use the viscometer cell is annealed at 550°C to remove fabrication strain.

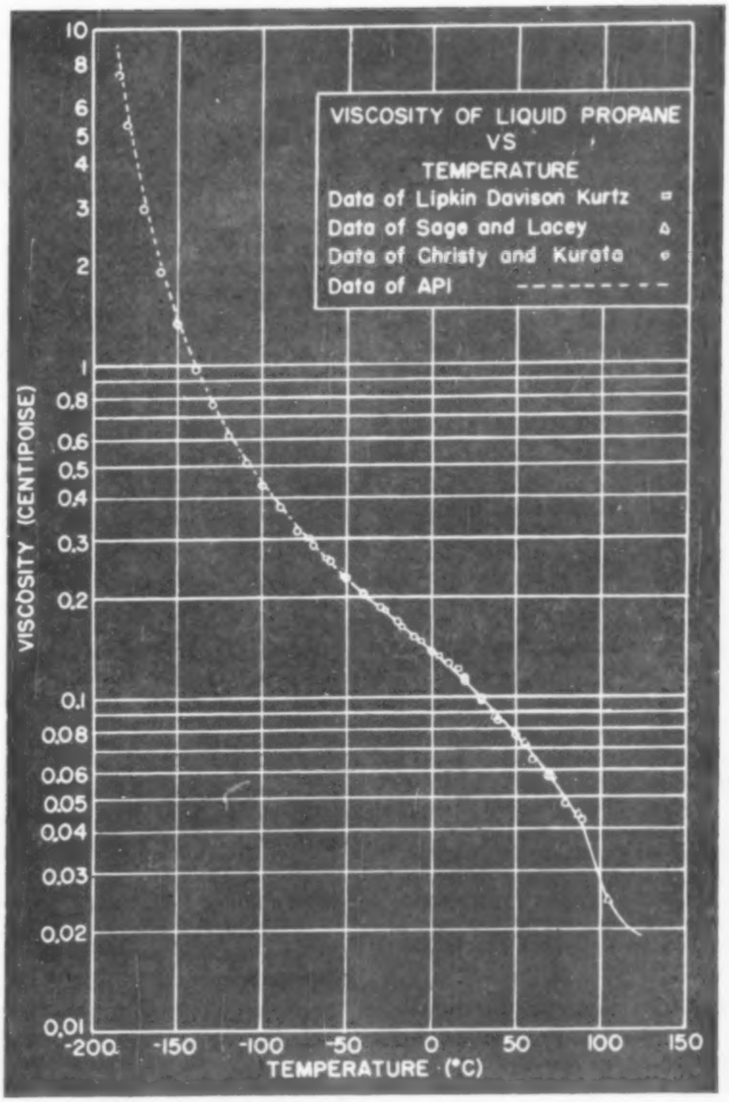

Figure 1. Viscosity of liquid propane vs. temperature.

The glass-to-metal seal between the viscometer cell and the ⅜ inch stainless steel tubing from the constant temperature box is shown in Fig. 6. The seal is effected by an "O" ring seated in a carefully machined groove on the "barrel." The viscometer cell is free floating; that is, as pressure is imposed in the cell, causing compression of the buffer beneath the cell, the cell may slip downward on the barrel to seat firmly. This type of adapter has been used satisfactorily up to 1000 lb./sq. in. abs.

The falling body used in this apparatus is a cylinder with hemispherical ends. The selection was based on two factors: cylinders can be read-

. . . factors behind the use of a cylindrical body construction for the equipment . . . the auxiliary equipment required

ily machined from a wide variety of materials, and cylinders permit hollow core construction thereby giving a wide range of body density.

Typical body designs are shown in Figs. 7a and 7b. The magnetic stainless steel collar used in the construction of the methyl methacrylate cylinders permits use of magnets to return body to drop position and detunes the timing inductance coils. When magnesium or aluminum cylinders are used, these metals also serve to detune the timer coils properly. However, since both are non-magnetic, an auxiliary means of returning the falling body to the drop position is required. A small, axially drilled nickel cylindrical "elevator" is provided for this. When the body is at the top of the viscometer cell, raising the magnet further causes the elevator to fall rapidly to the bottom of the cell. Since the body falls with a much lower velocity than the elevator, an adequate amount of time elapses for the subsidence of eddies before the body enters the zone where the time of fall is measured.

It should be mentioned that phase and volumetric data may be determined using this same apparatus by making a very simple modification. In place of the viscometer cell described, an equilibrium cell of the type described by Kohn and Kurata (1) is used.

The Auxiliary Equipment

The timer used is a Brush Digital Time Interval Meter which can be used to measure time intervals from 10 microseconds to 1000 seconds with an accuracy of ± 10 microseconds. It is activated by a voltage pulse, the amplitude of which must be at least one volt.

The timer pulse mechanism is shown schematically in Fig. 9. Two pulse units are required to operate the timer: one to start it, and one to stop it. Each pulse unit contains a driving oscillator, a tank circuit, a relay circuit, and a battery circuit. These units operate independently. Each is housed in a completely shielded chassis to prevent interaction of the two oscillators. The coils are in the constant temperature bath, and are connected to the pulse units by coaxial cable.

The operation of a pulse unit is as follows:

The tank circuit operates at a frequency set by the modified Pierce oscillator, and is tuned for resonance by varying the capacitor in the tank. When the falling body passes through the timer inductance coil, the tank circuit is thrown out of oscillation. The detuning effect causes a voltage change in the tank which is detected and rectified by the diode. This voltage change drops the set voltage level on the millisecond relay coil. When the voltage drops to a certain level the contacts close. The closing of the relay contacts completes the circuit in the battery-timer network and a voltage pulse of 1.6 v. amplitude is fed to the timer.

A check on the timer was made using a temperature independent standard. A synchronous motor with a gear reduction attachment unwound a cord suspending a steel weight. This weight passed through the timer inductance coils at constant velocity. The percentage error attributable to the timer and timer pulse units was determined by this method to be ± 0.2%. The majority of this error is attributed to the timer pulse units.

Acknowledgment

The Phillips Petroleum Co. provided financial support for this study. They also provided all the hydrocarbons used.

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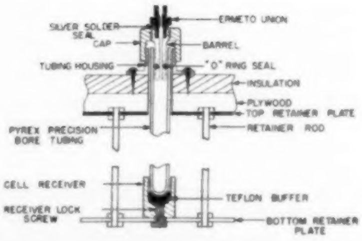

Figure 6. Schematic diagram of glass-to-metal pressure adapter assembly.

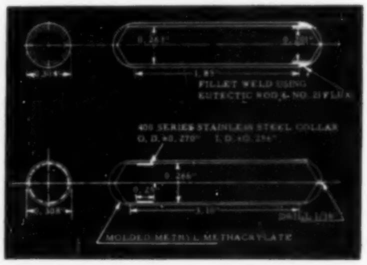

Figure 7a. Schematic diagram of falling body AL-304. 7b. Schematic diagram of falling body MM-308.

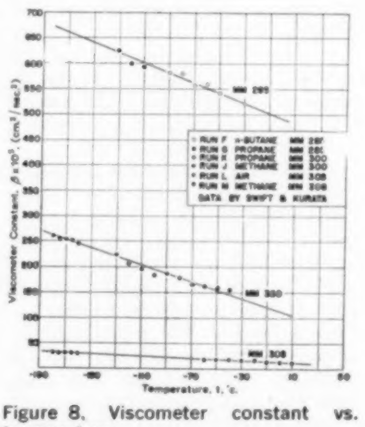

Figure 8. Viscometer constant vs. temperature.

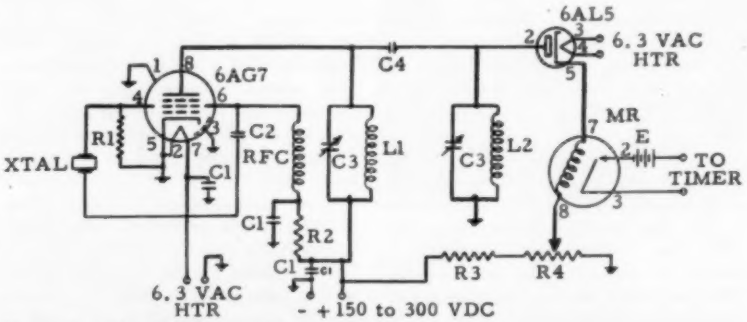

Figure 9. Circuit diagram of timer pulse mechanism.

Typical viscometer constants for three different falling bodies (MM 285, MM 300, and MM 308) in various media are shown in Figure 8.

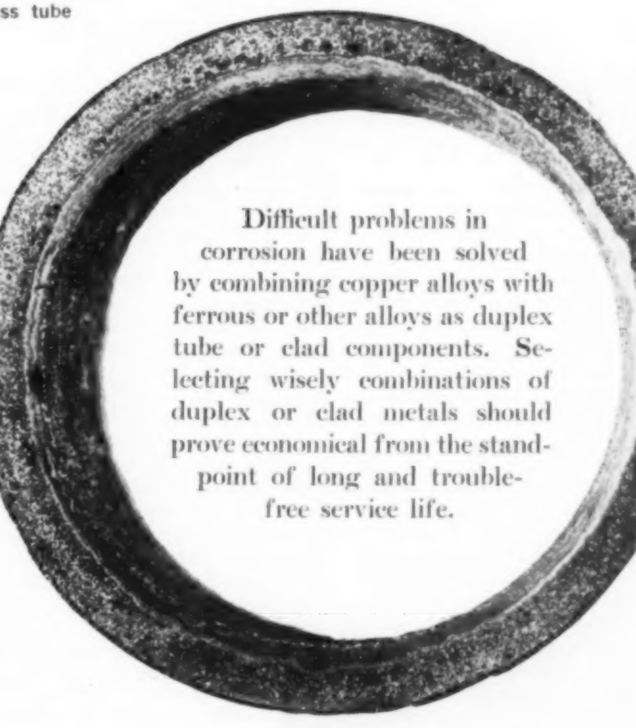

Figure 1. Layer-type dezincification inside yellow plumbing brass tube (Mag. 4X).

Difficult problems in corrosion have been solved by combining copper alloys with ferrous or other alloys as duplex tube or clad components. Selecting wisely combinations of duplex or clad metals should prove economical from the standpoint of long and trouble-free service life.

Copper alloys for corrosion resistance

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Many organic acids and most solvents and pure hydrocarbons are easily handled by copper and its alloys. The extensive use of copper alloys for heat exchanger and condenser tube is based on outstanding resistance to all types of cooling waters as well as on excellent heat transfer properties and ease of fabrication.

Discussions of the corrosion resistance of copper alloys are often concerned with media and operating conditions in which their behavior is either uncertain or unsatisfactory. Satisfactory performance is the rule nevertheless rather than the exception. The formation in many media of thin protective films of corrosion products often stifles corrosion almost completely. In some special applications, however, even extremely low corrosion rates are too high because they give trace contamination by copper which cannot be tolerated.

These alloys are unsuitable in concentrated inorganic acids (such as sulfuric and hydrochloric), dilute inorganic acids under oxidizing conditions, nitric acid or oxidizing salts in acid solutions, ammonia solutions, mercury or its compounds, or acid sulfides.

The solution of some corrosion problems has been quite difficult because tubes or other components have been unable to withstand corrosive conditions on one surface different from those on another surface. To solve these dual corrosion problems, clad sheet and duplex tube materials of construction were developed. In recent years chemical plant modernization and new construction have required such specially planned materials in increasing quantities and new combinations.

Clad tube sheet construction for exchangers avoids the complications and increased cost of double tube sheet design. Cladding with a corrosion resistant material such as copper alloy, Monel, stainless steel, or a precious metal is usually on steel which is used primarily for strength as well as low cost. It used to be almost impossible to obtain a copper alloy cladding on steel because of the difficult or impossible problems involved in bonding at high temperatures.

In recent years satisfactory methods of bonding have been developed by several vendors and a number of fabricators to make possible composite sheet material of many different alloys including the copper alloys. Field or plant application of the more recent bonding techniques is not practical under normal circumstances.

Duplex tube consists of two different alloys joined one within the other by mechanical or metallurgical methods. With mechanical bonded tube a wide variety of metal and alloy combinations is possible, but with the metallurgical bond there are few combinations available except in special tube. The particular combination of

. . . the advantages of a "tailor-made" tube for particular combinations of properties desired for a design

alloys and gauges selected may be based on dual corrosion conditions and/or requirements of both corrosion resistance and mechanical strength. The advantages of a "tailor-made" tube for a particular combination of properties desired for a special design have dictated the increasing use of duplex tube in chemical process equipment.

Many alloy combinations are available with an extremely heavy wall needed for high-pressure applications. Extended surface tubes are also made for external components of a number of nonferrous alloys. To avoid the danger of galvanic corrosion between the two tubular members of duplex, ferrules or sleeves of the same alloy as the liner are forced over the liners on ends where the outer members have been cut back to receive them. This protective treatment of tube ends is generally used for severe service conditions, with roller expanded tube installation into clad tube sheets.

A good example of a "natural" choice for a duplex tube combination is for ammonia refrigeration or cooling equipment where low carbon steel is on the ammonia side and copper or a copper alloy on the cooling water or brine side. When steel tube is used alone it is unaffected by the ammonia but is rapidly corroded and fouled by rust and slime on the cooling water side. The copper alloys of course will resist corrosion from the water, but are rapidly attacked by ammonia. The steel-copper duplex far outlasts plain steel tube for this service and, because of this resistance to corrosion and associated fouling, the original operating efficiency of new equipment is easily maintained.

A difficult corrosion problem was solved several years ago by the use of stainless steel over 70-30 cupro nickel duplex tube specially fabricated into nested combination heating and cooling coils (Figure 12). For the particular batch process involved stainless steel was suitable, but failures in the form of stress-corrosion cracking were encountered from the inside surface due to high chloride ion content of the raw water used for cooling. Since most of the copper alloys are highly resistant to cracking and corrosion from water and brine, it was decided to solve the problem by constructing the coil from duplex tube with cupro nickel to the circulating water side and stainless steel to the product side. In addition to its superior over-all corrosion resistance this combination of duplex had about 25% higher over-all heat transfer rate than the straight stainless steel coils. The expected improvement in heat transfer was realized during subsequent operation of the unit because it was possible to process an additional batch per shift.

Duplex with copper and 90-10 cupro nickel over stainless steel has recently been used to correct a severe pitting corrosion problem on the cooling water side. In other words, the copper alloys are finding increasing use in protecting other alloys from corrosive conditions in which the performance of these is unpredictable and that of the copper alloys is predictable.

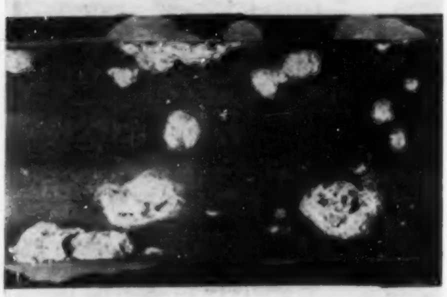

Figure 2a. Plug-type dezincification inside noninhibited Admiralty tube. Note whitish nodules of zinc-rich corrosion products (Mag. 4X).

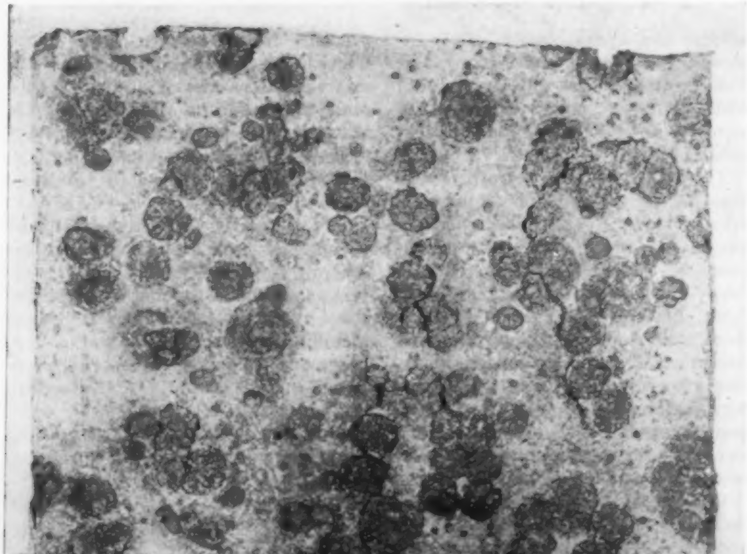

Figure 2b. Plug-type dezincification on inside of flattened, noninhibited Admiralty tube (Mag. 10X).

Types of Corrosion

The descriptive terms used by corrosion engineers to identify their problems point to the form or the way in which damage has occurred on a metal surface. These terms are useful in transmitting information because the manner in which corrosion has taken place is related to these terms. Corrective measures or trials can then be undertaken.

Since highly localized corrosion present as pitting, intergranular, or cracking usually occurs more rapidly and may result in abrupt failure, it receives prompt attention from the maintenance engineer. The progress of uniform corrosion attack is usually more predictable and therefore of less concern. A comparsion of the well-illustrated, common varieties of corrosion (*15*) and a description of these types as related to copper and its alloys (*18*) will show that dezincification is almost unique for copper alloys.

Dezincification—Dezincification is a

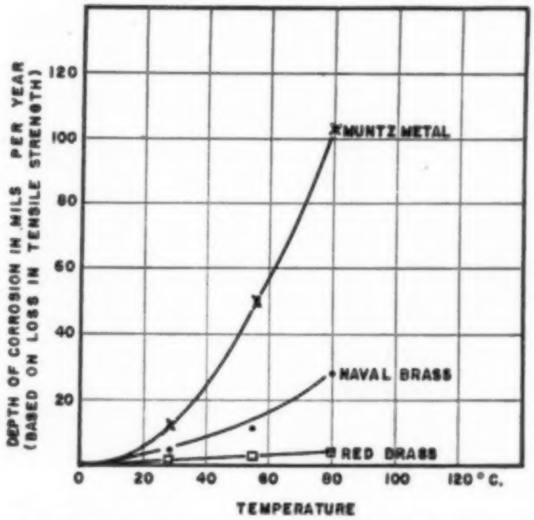

Figure 3. Temperature effect on dezincification corrosion.

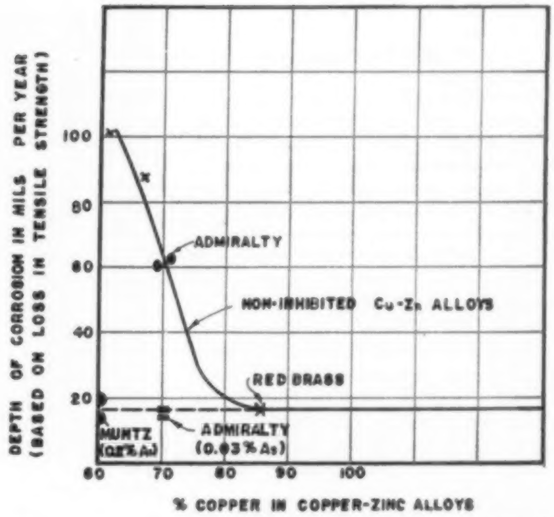

Figure 4. Corrosion rate of inhibited and noninhibited brass.

corrosion phenomenon in which both copper and zinc are dissolved from brass and the copper is redeposited as a weak, porous mass. Usually this does not occur in brasses of more than 85% Cu, or with lower copper content when an inhibitor such as arsenic, antimony, or phosphorus is used. Exceptions may occur in acid solutions or at elevated temperatures.

The uniform or layer-type of dezincification favors the higher zinc brasses such as Muntz metal (Figure 1), and the local or plug-type, the alloys with slightly less zinc such as plumbing brass and Admiralty (Figures 2a and 2b).

Stagnant conditions favor dezincification because the chances are better for the formation of scale or settling-out of foreign matter from the liquid. Beneath such deposits the rate of corrosion is usually accelerated from either concentration-cell attack and/or from the increase in temperature caused by the insulating effect of the deposit. The effect on dezincification of temperature and alloy composition is shown in the two curves in Figures 3 and 4.

Pitting. The accelerating effect of increasing temperature explains why careful operators try to maintain clean equipment. Other reasons for maintaining clean equipment include heat transfer efficiency, prevention of concentration-cell corrosion, and maintaining satisfactory product quality. By means of periodic inspection and cleaning, the condition of process equipment is known, and dangerous or troublesome deposits of foreign materials or process wastes are removed in time to avoid damage from corrosion as well as from inefficient operation.

In aqueous media at moderate temperatures foreign materials deposited on a metal surface as particles or flakes will frequently stimulate pitting corrosion by local cell action. This is usually by oxygen concentration cell in areas beneath particles or deposits where the deficiency in oxygen in relation to the surrounding areas acts to form local anodes where pitting corrosion takes place. This type of corrosive attack in shielded areas beneath deposits is often called "deposit attack." Similar concentration-cell action may take place also in crevices and loose joints ("crevice attack") or near liquid-to-gas junctions ("water-line" attack).

The highly localized corrosion pitting shown in Figure 5 caused failure of phosphorus deoxidized copper tube after fifteen years' handling a mildly corrosive steam condensate which probably contained carbon dioxide and oxygen. Corrosive condensate grooving and general thinning of copper tubes of a shellac cooler resulted in failures after slightly over five years as illustrated in Figure 6.

The distinctive pattern of localized pitting, shown in Figure 7, is called "impingement corrosion" and was caused by operation at too high a cooling-water velocity for the type of water and alloy used. This type of attack is often associated with the presence of entrained air and abnormally high cooling-water velocities. Similar damage can occur also with other metals and alloys which are used under service conditions where a normally protective film of corrosion products cannot be maintained in the flowing fluid or gas. Figure 8 shows vapor impingement corrosion on the outside of Admiralty tubing near the outlet of a gas cooler.

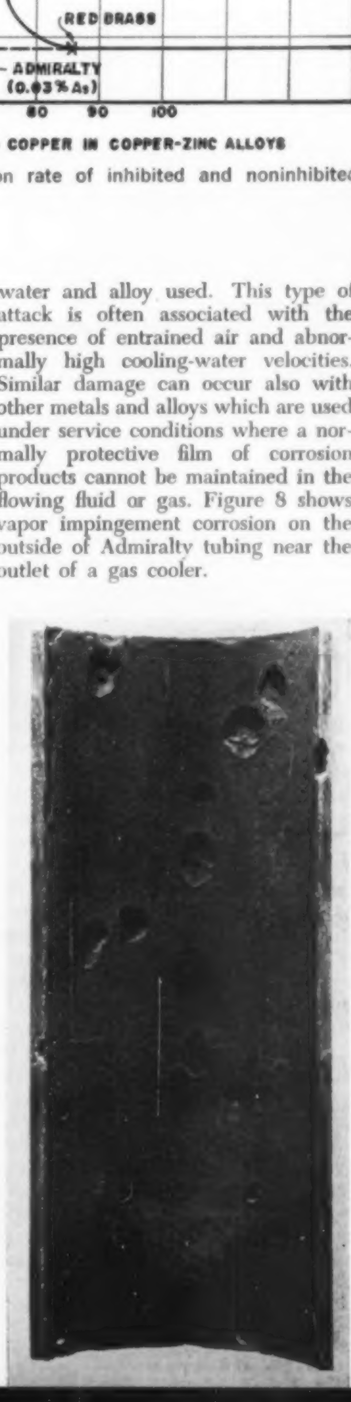

Figure 5. Pitting corrosion on inside of phosphorus deoxidized copper tube after 15 years' handling steam condensate. (Mag 4X).

. . . interpretation of the causes of a particular corrosion problem is difficult

Cracking. Both stress-corrosion cracking and corrosion-fatigue have been placed under the broader heading of corrosion cracking because the two types of damage are often confused from a practical viewpoint. There are of course certain differences which involve causes and effects and the particular corrective measures required for each problem. In any alloy system the necessary ingredients for stress-corrosion are stress and a corrosive agent. The stress—either residual and/or applied—must be higher than a certain minimum value for the alloy and the particular corrosive medium involved. The concentration of the corrosive agent at susceptible areas on the metal surface must be sufficient to be active. Corrosion-fatigue is a combination of both corrosion and fatigue acting together to produce more severe and more rapid damage than would either factor by itself.

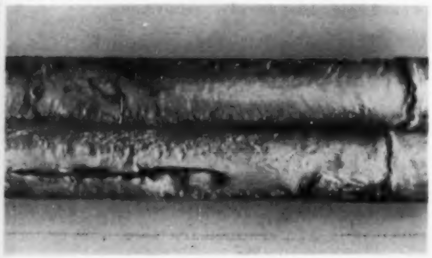

Figure 6. Condensate grooving and general thinning of copper tube after about 5 years' service handling shellac-ethanol vapors with traces of hydrochloric acid.

Stress-corrosion cracking of copper alloys has been described in considerable detail by many authors, largely because of the early interest in the cracking of brass cartridge cases. Although the most prevalent corrosive agent is ammonia acting with moisture and air or oxygen, mercury (or its salts), and liquid metals can also act in combination with stress to produce stress-corrosion damage. Interpretation of the causes of a particular stress-corrosion cracking problem is often difficult because there are usually several sources of the required stress and, sometimes the corrosive agent may be difficult to trace. Stress - corrosion cracking by mercury and liquid metal is always intercrystalline. Cracking by ammonia is almost exclusively transcrystalline in Admiralty, but most often intercrystalline in the pure binary alloys.

Stress-corrosion cracking failure of Admiralty condenser tubes took over eleven years to occur in the air-removal section of a large surface condenser for a steam turbine. The transverse cracks shown in Figure 9 were apparently produced slowly by small amounts of carbon dioxide, air, ammonia, and moisture which acted in combination with extremely slight bending stresses in or on the tube.

The corrosion-fatigue crack illustrated in Figure 10 is adjacent to the tube sheet on a bell-end and finned aluminum brass tube. The damage was caused by resonant vibration of the tube of sufficient amplitude to create metal fatigue, which at the same time was aggravated by the mildly corrosive cooling water within the tube. Corrective measures should involve one or more of the following: reduce or eliminate the source of vibration by isolation, insulation, or damping; use an alloy such as 70/30 cupro nickel, which is more resistant to fatigue; treat the cooling water to reduce its mild corrosivity. Shown in Figure 11 is a photomicrograph of shallow intercrystalline attack of the surface which acted as a stress raiser for fatigue producing stress and resulted in a transcrystalline corrosion-fatigue crack.

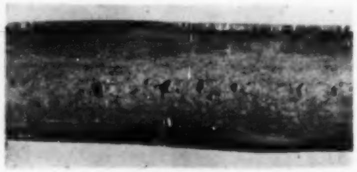

Figure 7. Impingement corrosion pitting from excessive cooling water velocity. Direction of flow from left to right.

Figure 8. Vapor impingement corrosion near gas outlet on outside surface of Admiralty tube.

As we learn more about the exact conditions in which the various alloys and metals give the best performance, it should be possible to select combinations of duplex or clad metals which will be economical from the standpoint of long and trouble-free service life. The copper alloys will certainly have their place in this picture because of their generally good corrosion resistance to a wide range of corrosive chemicals, particularly under nonoxidizing conditions.

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Figure 9. Stress corrosion cracking of Admiralty tube after 11 years' service condensing steam containing carbon dioxide and ammonia.

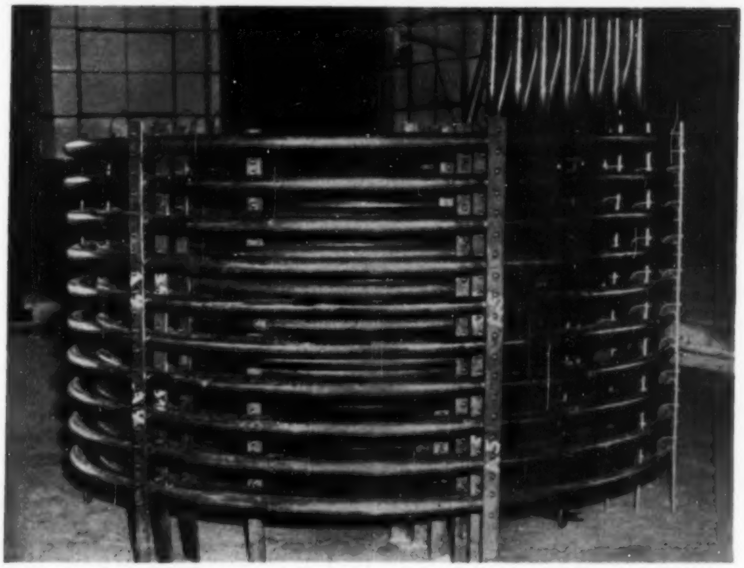

Figure 12. Nested heating and cooling coil assembly of Stainless Steel-Cupro Nickel duplex tubing.

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Acknowledgment

Acknowledgment is hereby made to the many individuals who have contributed to this paper either directly or indirectly. Special appreciation is due Miss B. V. Dolan for her help in the preparation of the illustrations and C. L. Bulow for his help and suggestions on background material.

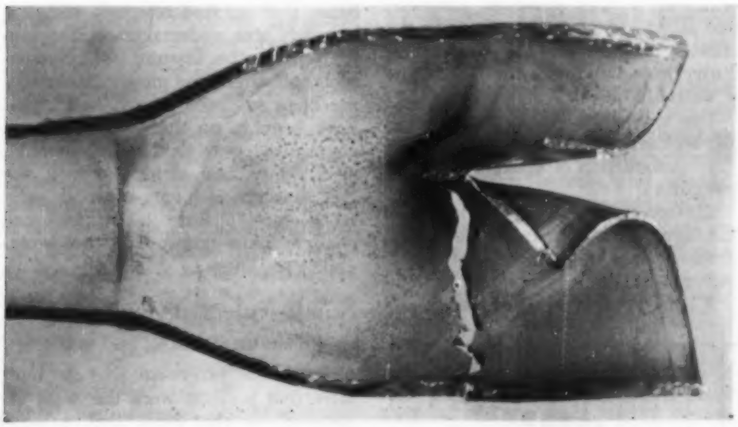

Figure 10. Corrosion-fatigue crack adjacent to the tube sheet on bell-end and finned Aluminum Brass tube (Mag. 4X).

Figure 11. Transverse, transcrystalline corrosion-fatigue crack beneath shallow intercrystalline surface corrosion from cooling water inside tube shown in Figure 10 (Mag. 250X).

Projecting the profitability of new products

Common sense, good judgment, and the element of luck all contribute in some measure towards the evaluation of the future possible prospects of a new chemical undertaking. The evolution of the steps in marketing analysis learned by one company are presented here.

T. T. Miller

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Crystal ball gazing is going out of fashion as a means of trying to project the profitability of new products. Certainly it would be simpler than some of the methods now employed, and perhaps because of its contemplative and studious approach it might be better than no method at all.

What are the improved ways in which a company utilizes its experience, research, and manpower before embarking on a new field or a new product line? How do the men at the top arrive at a decision that may change their whole course of action and "make" or "break" their company?

Methods for arriving at profitable decisions have been discussed in most of the business journals for decades. The intention here is not to rehash all the splendid words that have been written on the subject, but rather to relate the steps one company uses in projecting the profitability of new products.

This is an age of diversification. Some of it stems from research and development which has produced new ideas that have gone onto the drawing board and then into the market place. Some of it comes about because markets start drying up, and there is a growing and sickening realization within a company that unless it goes into another field, the market is not going to need its product or service any more.

But once a firm has concluded that it must have something new, just how does it go about finding it?

In this article the subject will be down into two general areas. First, a description of how Grace decided what to do in the chemical industry after years of study had narrowed down the selections of new fields to this general area; then more specifically citing the various factors which should be taken into consideration in projecting the profitability of new products to be added to already existing businesses.

Preliminary considerations

In looking for a field of diversification, we inaugurated studies that seemed endless. We literally looked at everything. We put our best people on the job, we hired new talent for the purpose, we met with consultants.

The consensus was that the greatest growth potential lay in the United States chemical industry.

In 1952, after we had decided to enter the chemical industry, we set up a group that corresponds to today's commercial chemical development department. We hired engineers, chemists, market researchers, economists and financial analysts for our staff. These men took a task force approach to the problem. They categorized and classified the entire chemical industry by breaking it down into segments. This in itself was a momentous approach and required considerable road work in getting to know the entire industry better.

In many respects, a large part of this earlier study was justified if only for its educational benefit.

It soon became apparent, however, that it was far easier to identify the attractive segments of the chemical industry than it was to find an avenue of entrance.

The methods of entry into chemicals that seemed to exist were:

1. Acquisition of existing chemical companies,

2. Construction of plants based on the licensing of already developed processes available through engineering companies,

3. Initiation of a large research and development organization and the eventual commercialization of results.

After considerable discussion of these alternatives, it became apparent that no single one represented the answer, rather a combination of all three formed the groundwork of the general plan. During the earlier years, the emphasis was to be on acquisitions. Then, as we developed a position in the chemical industry, the construction of new plants based on purchased processes would become practical. Subsequently, the development of our own large research staff could form the major base of our growth in the years ahead.

The textbook approach

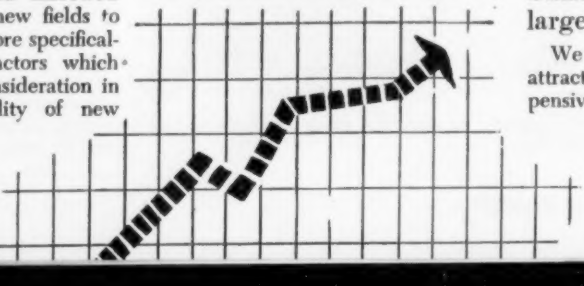
Our people then took a text book approach to the next phase of the problem and studied a variety of chemical opportunities on which we could base new chemical ventures. As these were further screened, a thorough analysis of profitability was made, using the classical approaches of Market Studies, Engineering Studies, Plant Location Studies, Customer Studies, Transportation Studies, and so on.

These studies were summarized in two sets of reports. The first was a preliminary report which covered everything the long report did, but with "guesstimates" supplied where details were lacking. Then, if the chemical was not eliminated because of its lack of profitability, a more extensive analysis was undertaken.

There are, however, certain drawbacks in using the sophisticated pedantic approach. For example, in 1952 and 1953, one of the chemical groups in the plastics field looked promising enough to warrant the usual treatment. After we finished the study, we decided there wasn't enough profitability in this direction. But, shortly thereafter, another firm took the license that we had rejected, and new research was undertaken in the laboratory of the licensor which completely changed the picture. If we had not been so "book-happy," we might have been in on the ground floor of an exciting new field with unlimited profitability. So don't overlook the fact that the elements of good judgment and "a little bit o'luck" can change many graphs in the profitability studies.

Small-scale entrance—large-scale plans

We found, of course, that the most attractive projects were the most expensive, in the sense that a good



chemical company would join with us only on the basis of a high price-earnings ratio. Also, we found that almost any growing chemical product which could be entered by purchasing an available process would show only a modest profitability after competition began to intensify. In short, the profitability figures of the various alternatives had to be compromised with a realistic appraisal of what we thought we could handle. We had to postpone some of the more glamorous projects until we had built up a chemical organization, and we had to settle for a more gradual stable entry into the chemical industry.

In fact, when we decided to make ammonia and urea, we knew the venture would be only modestly profitable, but at least these products were practical from a technological standpoint. In effect, we were beginning with a growth segment of the industry where more profitable expansion could be undertaken once we had an ammonia and urea plant under way.

At present, we feel that we are well along the road we originally set out to follow. Our new polyethylene project, while it still represents the purchase of an available process, nevertheless requires considerable research and development by us for successful commercialization. Grace is now staffed to handle this work.

As for the more advanced stage of Grace's development—the creation of new products completely within our own research and development group—we have advanced quite far in the organization of our central research and development division. In fact, the construction of a new research center is nearing completion.

The growth rate of the chemical industry

The chemical industry attracted us because it has enjoyed an 11% average annual rate of growth since the war, compared with an average of 5% for all industry. A very important reason for this is that, on the average, the chemical industry spends 3% of its sales dollar for research, while industry as a whole spends about 1%.

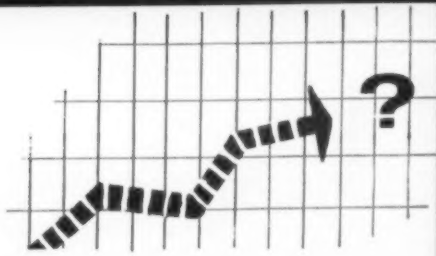
There have been several studies in recent years which have shown that for each dollar invested in new product research, the chemical industry realizes about $6 in new product sales—a productivity ratio of six to one. It is interesting to note, therefore, that, to grow 11% a year instead of 5% (an improvement of six percentage points), an average chemical company would require an average annual investment in *new* product research of 1% of the sales dollar. That still leaves 2% out of the chemical industry's 3% for sustaining research to keep the older products up to date.

For example, a company may earn an average of 20¢ before taxes, or 10¢ after taxes, on each dollar of the annual sales of its older products. It pays out 5¢ in dividends and retains 5¢ in the business. In addition, it generates, on the average, 5¢ in annual depreciation write-offs; so there is a cash flow of 5¢ plus 5¢—or 10¢ per sales dollar—to invest in expansion. In the chemical industry, this is just about the right amount to invest for 10¢ worth of new sales, or a 10% annual growth which can be financed out of the cash flow generated within the business itself. This means that generated money looking for new products needs new product research to put it to work. This is especially important in the chemical industry, where technological obsolescence is high and where competition is intense. The technological obsolescence requires that new products be developed to replace many of the old ones from which the 5¢ of depreciation money comes. The keenness of competition means that as the profitability of older products slides from 15 to 10 to 5 per cent, new 15% yielders must receive priority to keep the overall average earnings sound.

The screening process

Several questions that the research manager must answer are: "How do I winnow out the promising ideas from the duds? Which new products are headed for a profitable upswing instead of a painful obsolescence?" A screening process is needed for sorting ideas—beginning with a coarse screening, then successive screenings that increase in fineness until the projects that are left to be studied are few enough in number and promising enough in calibre to concentrate upon in the final fine analysis.

The early screenings can be largely qualitative, almost a series of check-off points. In the Polymer Chemicals Division we plan to examine a number of factors step by step, and for each factor we will assign the new product idea a rating of *very good, good, average, poor* or *very poor*. The factors are then arranged into groups, and for each group we will have a chart on which the ratings of the individual factors can be spotted and subsequently connected by means of a profile line. After we have completed the chart for each group of factors, the entire profile of the new product can be spread out and examined. Too many



poor or *very poor* ratings will show up visibly and vividly, and the new product idea can be discarded. If the profile hovers back and forth mainly near the *average* line, the new product idea ought to be put on the shelf. It may, however, be reexamined after we have run out of brightly promising ideas whose profiles show a goodly proportion of *good* and *very good* ratings and few, if any, *very poor* ratings.

We do not feel that it is feasible to design a constant numerical weighting for each factor. But we do apply the judgment factor, and discount any *very poor* or *very good* ratings which seem to have relatively minor importance in the particular project under study. After this, we appraise the profile as a whole.

Let us now run through the groups of factors that comprise our qualitative screening.

Stability factors

The first group of factors considered in our qualitative screening consists of six *stability factors*.

1. Durability of Market. A basic commodity such as sulfuric acid, for which there will always be uses, would be rated *very good* on this factor. On the other hand, a product going into a textile end use which is starting to become obsolete would rate *very poor*.
2. Breadth of Market. A product used both nationwide and abroad by a wide variety of customers would be rated *very good*, while a product used in just one step of a process peculiar to a small number of manufacturers located in the Pacific Northwest would be given a *very poor* rating, unless this rating could be improved by favorable long-term contracts with reliable purchasers.
3. Possibility of Captive Market. An *average* rating would be given to a product for which there is a potential use within the company but which can be bought from outside suppliers at such favorable prices that the return on investment for our own facilities would be border-line.
4. Difficulty of Copying. A product covered by a strong patent and manufactured by a unique process from intermediate materials produced only by our company would rate *very good*.
5. Stability in Depressions. A prod-

uct distinctly in the luxury class where purchases can easily be postponed would be rated *very poor*, while one that is an essential constituent in staple low priced consumers' perishables should get a rating of *very good*.

6. Stability in Wartime. A product which would almost immediately be denied allocations of critical raw materials in wartime would draw a rating of *very poor*, whereas a product which would be in heavy demand as a replacement for other more critical items would be rated *very good*.

Growth factors

Five growth factors to be taken into account are:

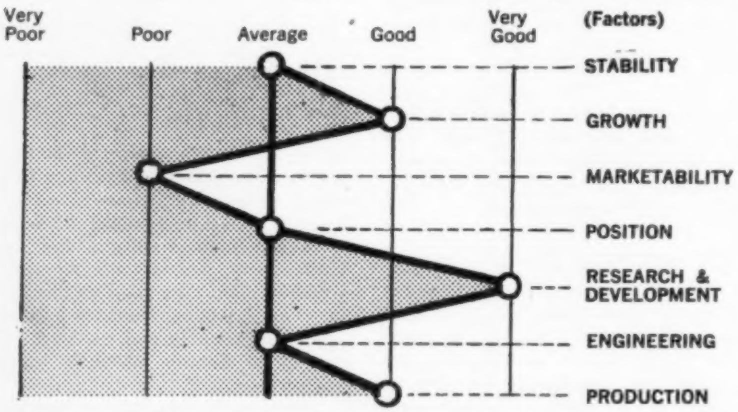
1. Unique Character of Product or Process. A product that can fill an important unsatisfied need or that can rapidly—and without interference—replace a higher priced material should rate *very good* for this factor.

2. Demand-Supply Ratio. Although the product may not be unique, if there is room for a new supplier because the demand is expected to outgrow the supply, it should rate *very good* so far as this factor is concerned.

3. Rate of Technological Change. If there is a wave of change looming up on which this new product can ride, it draws a rating of *very good*. On the other hand, a product which is merely expected to grow commensurately with the growth of population and of standards of living would get a rating of *average* in this factor. A product that is fast losing ground technologically would rate *very poor*.

4. Export Possibilities. If the sales growth of the new product can be markedly accelerated by adding export sales to domestic sales, it deserves a rating of *very good*.

5. Utilization of Management Personnel. A new project would rate *very good* on this factor if it offered an opportunity to promote potential management talent into enlarged responsibilities, yet did not unduly deprive existing products of their essential management and did not unduly tax top management's time and effort.



By charting, the entire profile of a new product can be seen at a glance and examined.

Marketability factors

Eight *marketability factors* may be summarized as follows:

1. Relationship to Existing Markets. A product which can be sold to our present customers through our present sales organization rates *very good*. A product that requires our understanding of an entirely different field from any we are now selling, requires an entirely different sales organization or must be marketed through entirely different distribution channels rates *very poor*.

2. Company's Reputation in Allied Field. Although prospective customers in a new field may not be the ones to whom we are now selling, if we are highly regarded in an allied field, we may nevertheless have an advantage, and the product should be rated *very good* on this factor.

3. Relationship to Probable Competition. If other suppliers have neglected their markets and handled their trade relations badly, we can give the new product a rating of *very good* on this factor. If, on the other hand, the other suppliers not only have served their customers extremely well but buy from these customers as much as they sell to them, we should use a rating of *very poor*.

4. Company's Ability to Meet Customer Service Requirements. Since the Polymer Chemical Division of W. R. Grace & Co. has a modern, well-equipped and well-staffed plastics application laboratory, a new product would rank *very good* if its applications could be studied and demonstrated in the same molding, extrusion and coating equipment as we now have. If it were a first cousin—say, a rubber compounding ingredient—we would rank it *good*, but if it had no relationship whatsoever to any of the techniques we now master, it would have to be assigned a rating of *very poor*.

5. Relationship to Customers' Products. We would have to rate a product *poor* or *very poor* if it were the same type of product our customers make, or if it were a different type but tended to take business away from them or detract from their business profitability.

6. Large Volume with Individual Customers. When customers buy in large volume, selling and servicing expenses will ordinarily be relatively low; also the larger customers may have adequate evaluation facilities which could be of importance during the development stage. All these conditions will give the new product a rating of *very good* which, to some extent, offset a *very poor* rating in the Breadth of Market Factor listed under the Stability heading.

7. Few Variations or Styles Required. If it is evident that a new product requires a wide variety of grades, styles, and packages that will result in poor manufacturing economies and cumbersome inventories, the product will have to be rated *very poor* in this factor. This will be especially true if style changes could leave the company with obsolete inventories.

8. Freedom from Seasonal Fluctuations. The product that rates *very good* on this factor is one that can be made, stocked and sold at a steady rate all year round. The rating must be lowered as seasonality creeps in, particularly if the off seasons coincide with off seasons of other products made in the same plant or sold through the same channels.

Position factors

Another group contains *five position factors:*

1. Time Required to Become Established. Our position is more secure if we can complete our development work, build our facilities and become established before there is any serious change in economic, technological or competitive conditions. The new product which can be commercialized most rapidly therefore rates *very good* on this factor, whereas the one which has a longer, more difficult development period ahead must be rated *very poor*.

2. Value Added by In-Company Processing. Our position is more se-

cure, and the new product's rating on this factor will be higher, if we handle the entire processing rather than act merely as a convertor at one step.

3. Exclusive or Favored Purchasing Position. If we can absorb the entire output of a scarce and particularly advantageous raw or intermediate material that is produced by a highly reliable contract source, our position is more secure than if a competitor has access to the same material.

4. Improved Purchasing Position. If the new product's commercialization steps up our purchase of certain raw materials into the carload or tank car class, or enables us to contract more favorably for raw materials, a *very good* or *good* rating is assigned to this factor.

5. Availability of Raw Materials Within the Company. This factor rates a *very good* or *good* mark if a raw material for the proposed product is already made or can be made elsewhere within the company.

R/D factors

There are *four research and development factors:*

1. Utilization of Existing Knowledge. The less the uncharted territory to be explored in the laboratory, the more the chances of success, and the better the rating for this factor.

2. Relationship to Future Development Activities. A project which is closely related to the main lines of the company's future activities and which will broaden the know-how fundamental to those activities will receive a far better rating than one which takes us down a side street.

3. Utilization of Existing Laboratory or Pilot Plant Equipment. This saves time and money and is worth a high rating. The necessity for constructing new research facilities or acquiring and learning to operate large amounts of new equipment swings the rating towards the unfavorable side.

4. Availability of Research and Development Personnel. The unavailability of the right talent within the company and the difficulty of locating it outside (unless it can be obtained by farming out research to university or consultant laboratories) is a factor to be weighed carefully and rated accordingly.

Engineering factors

The engineering factors are three in number:

1. Reliability of Process Know-how. Many a new project runs well over its original cost estimate because the difficulties of developing an as yet untried process step were underestimated.

2. Utilization of Standardized Equipment. If the available process data indicate that standard equipment will fit the process, the element of risk is reduced and the rating for this factor can be a high one.

3. Availability of Engineering Personnel. The same considerations which were rated in the case of research and development personnel are also applicable.

Production factors

The final group contains *eight production factors:*

1. Utilization of Idle Equipment. The advantages of this possibility are obvious.

2. Utilization of Surplus Steam, Electric, and Water Capacities. The surplus utilities should be reviewed as to posible other future demands on them, and if truly surplus, should be considered a strong plus value in rating the new product on this factor. If on the other hand, the new product would only fit into a plant where expansion of water supply, for instance, would be very expensive, it would receive a *very poor* rating on this factor.

3. Utilization and Upgrading of By-Products. There is an obvious advantage if this situation exists.

4. Utilization of Processes Already Familiar to Company Personnel. The high cost of training employees in new processes where necessary warrants a *poor* or *very poor* rating.

5. Availability of Production and Maintenance Workers. If the new product is being considered for manufacture at an existing plant, both the quantity of labor available and the new categories of jobs required should be weighed and rated.

6, 7, 8. Freedom from Hazardous Operating Conditions, Difficult Maintenance Requirements, and Waste Disposal Problems. All three of these factors will, of course, be estimated quantitatively when the operating costs are projected, but they also deserve a qualitative appraisal during the screening process.

The total profile for the new product idea covers 39 factors. If an idea shows a good profile, we are then ready to do further work on it. Thus we can concentrate our attention on the ideas that have survived this screening, without diluting our efforts by pursuing lengthy studies on those that should be discarded or put onto a reserve shelf.

Estimating cost and forecasting profitability

Actually, there seems to be no magic formula for appraising the profitability to the last degree in accuracy. At W. R. Grace & Co. we use such conventional gauges as return on investment, cash flow analysis, pay-off period, and break-even analyses. We also try to make these same estimations for our competitors, to see whether they may have particular advantages or disadvantages.

In estimating cost and forecasting profitability for new projects, we try to be realistic. We try not to be too conservative and allow for too many contingencies, and, at the same time, we try to avoid overoptimism. Thus we assume that, over a period of time, raw materials, wages and plant operating costs will continue to inflate and that the product may actually suffer a technological price deflation as companies learn how to make it cheaper and better. We also assume that competition will grow keener, and that our sales volume will grow. We assume, too, a modest profitability picture for the new polyethylene; however, our long-range plans are to enter the plastics field, and we feel that this is a good place to start. Obviously, we won't discover new technological advances in plastics if we are on the outside looking in. It is much better to have a functioning, efficient team that can assimilate the growth in polymer chemistry that research is sure to bring.

The American Alcolac project-rating system

A project-rating system which has been developed by the American Alcolac Company of Baltimore is summarized by the formula below:

This formula does not, of course, supply any radically new information, but it does force management to crystallize its information on each project so that decisions are made on an objective instead of a subjective basis. The formula is really a ratio of total net profit expected during the

$$\frac{\text{Chances of Technical Success} \times \text{Chances of Commercial Success} \times \text{Annual Volume} \times (\text{Price} - \text{Cost}) \times \text{Life}}{\text{Total Costs}} = \text{Project Number}$$

life of the project to the total cost of initiating the project. Since American Alcolac is a small company and is anxious to favor those projects which provide a fast rate of return, it decided to use the square root of the life of the project.

The high cost of poor judgment

An error in estimating the *price* or the *sales volume* of a proposed new product can be much more costly than a wrong guess on the cost of the plant.

For example, suppose a company decides to embark on a project requiring a capital investment of 10 million dollars. Let's assume it will need 10 million dollars in sales to earn 15% net profit after taxes. If the company underestimates the amount of capital needed by 20% but still maintains 10 million dollars worth of sales, its return on investment will be reduced only 2½%. However, if the company's estimate is 20% wrong on gross sales (through over-estimating the sales volume, the sales price, or both), the rate of return will drop almost to one-half of the original target estimate.

Poor judgment can be expensive in many ways. It may result in a lack of adequate allowance for start-up costs of new projects, or the allocation of insufficient application research funds to get the new product launched.

A new product's failure can't be blamed on research alone. Process engineering, pilot-plant work, production estimating, and marketing research must all be high grade to avoid costly errors.

Conclusions

In order to reach sound decisions based on all the factors to be considered, a company must develop a new product planning team composed of men from *every* phase of its organization. This team should have adequate staffs available to help attack all the factors that may lead to vulnerability in the planning operation.

When the team is well coordinated, sounder decisions will be reached, and management will have confidence in them. Experience has shown, too, that these decisions can usually be arrived at faster, once the group learns to function as a team.

Qualitative screening procedures are important, and quantitative profitability analyses are essential; but most vital of all is keen judgment exercised at every step in the selection of new projects by all the talent available.

Presented at A.I.Ch.E. New York Section One-Day Meeting.

High energy hydrocarbon fuels

In the past petroleum hydrocarbons furnished the bulk of fuels for aviation. However, certain hydrocarbons of the acetylene and cyclopropane families by virtue of their extra energy, yield fuels which have higher specific impulses and increased reactivity (resulting in smoother combustion in engines). Possible methods of producing such fuels are reviewed, and several commercial processes are reported.

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Petroleum hydrocarbons have been excellent fuels for air breathing engines for a number of reasons: low cost, excellent logistics, good storage ability, thermal stability, high heat of combustion, and in general good handling properties. However, for application in certain types of power plants, a somewhat greater amount of energy is desired. Additional energy can be imparted to a hydrocarbon by creating strain in the molecule, through a ring structure such as cyclopropane, or through an acetylenic bond. Higher energy not only gives higher specific impulses to the fuels, but may usually impart increased reactivity to the molecule which is useful in permitting smoother combustion in an engine.

The additional energy thus obtained is reflected in the heat of formation. For acetylene, this is a positive quantity indicating that acetylene spontaneously releases heat on decomposition. A comparison of the heats of formation and combustion of the ethane, ethylene, acetylene series and propane and cyclopropane, is shown in Table 1.

In the case of multiple adjacent unsaturated bonds, this extra energy is slightly decreased by the resonance energy. However, these compounds still possess more available energy than the saturated hydrocarbons, as indicated by the heats of formation listed in Table 1 for the series butane, butadiene, vinyl acetylene, and diacetylene.

The heats of formation of vinyl acetylene and diacetylene were calculated by the method of Souders, Mathews and Hurd (*1*) and Franklin (*2*). An estimation for the resonance energy correction for diacetylene of 5 kcal./mole was made from Skinner (*3*) which involved measuring heats of hydrogenation of *diyne* systems.

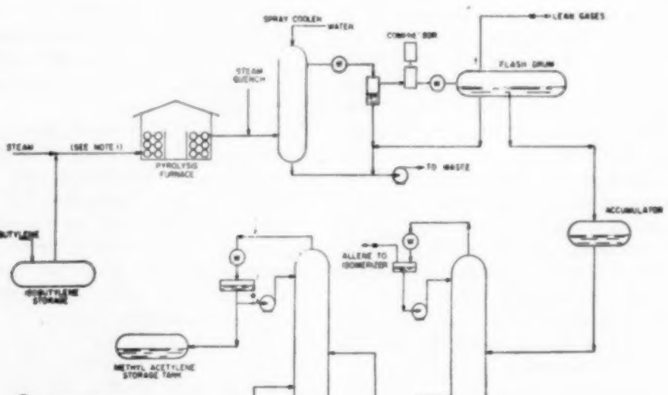

Figure 1. Methylacetylene via isobutylene and tertiary butyl alcohol

The higher energy of these compounds is also evident in values for their specific impulses when used as fuels in liquid bipropellant rocket systems. Calculated values for specific impulse as compared to other systems are presented in Table 2.

Table 2—Specific impulse values

Oxidizer	Fuel	I_s at 500 lb./sq. in.abs.	I_s at 1000 lb./sq. in.abs.
Oxygen	Gasoline	264	290
Oxygen	Acetylene	288	307.7
Oxygen	Cyclopropane	274	293.5
Nitric Acid	Gasoline	240	255
Nitric Acid	Acetylene	259.7	277.2
Nitric Acid	Cyclopropane	246.4	263.2

Table I—Heats of Formation and Combustion for a Group of Selected hydrocarbons

Compound	Mol. Wt.	ΔH_f[1] cal./gram	ΔH_c[2] cal./gram	Reference
Ethane (g)	30.068	− 673.01	−11,350	A.P.I., Dec. 1952
Ethylene (g)	28.052	+ 445.46	−11,272	A.P.I., Dec. 1952
Acetylene (g)	26.036	+2,081.50	−11,526	A.P.I., Dec. 1952
Propane (g)	44.094	− 562.89	−11,079	A.P.I., Dec. 1952
Cyclopropane (g)	42.078	+ 302.77	−11,879	A.P.I., Dec. 1952
n-Butane (g)	58.120	− 518.75	−10,927	A.P.I., Dec. 1952 (29)
1,3 Butadiene (g)	54.088	+ 486.80	−10,648	A.P.I., Dec. 1952
Vinyl Acetylene (g) ..	52.072	+1,336.6	−10,781	Calculated
Diacetylene (g)	50.056	+2,079.7	−10,750	Calculated

1. Heat of formation of substance in its standard state as a *gas* at 25°C. Carbon is taken as solid graphite.
2. Heat of combustion at constant pressure as gas at 25°C to give H_2O (g) and CO_2 (g).

Substituted cyclopropanes

Derivatives of cyclopropane are of interest and can be prepared as follows:

Cyclopropyl cyanide (*4*):

$$Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}Br + KCN \rightarrow Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}C\equiv N + KBr$$

$$Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}C\equiv N + \xrightarrow{NaNH_2} \underset{\diagdown\ CH_2\ \diagup}{CH_2 - CH}\text{-}C\equiv N + NaCl + NH_3$$

Vinylcyclopropane as prepared in the N. Y. U. laboratories (*5*):

$$CH_3\text{-}\underset{\underset{O}{\|}}{C}\text{-}\underset{\diagdown\ CH_2\ \diagup}{CH-CH_2} + LiAlH_4 \rightarrow CH_3\text{-}\overset{H}{\underset{OH}{C}}\text{-}\underset{\diagdown\ CH_2\ \diagup}{CH-CH_2} \qquad (70\text{-}75\%\ \text{yield})$$

$$CH_3\text{-}\overset{H}{\underset{OH}{C}}\text{-}\underset{\diagdown\ CH_2\ \diagup}{CH-CH_2} \xrightarrow[\Delta]{Alumina} CH_2=\overset{H}{C}\text{-}\underset{\diagdown\ CH_2\ \diagup}{CH-CH_2} + H_2O \qquad (50\%\ \text{yield})$$

The preparations of numerous cyclopropyl hydrocarbons have been described by Slabey and co-workers (*6-13*).

Substituted acetylenes

Substituted acetylenic hydrocarbons may be prepared by a variety of techniques of which the most importtant are pyrolysis, liquid ammonia condensation, and dehydration of acetylenic alcohols. Less important methods include dehydrohalogenation, carbide decomposition, and dimerization of lower acetylenic compounds.

Pyrolysis

The various pyrolytic processes for the production of acetylene from natural gas yield appreciable amounts of higher acetylenes as byproducts. For example, in the arc process for acetylene from natural gas as carried out at the Chemische Werke Huels plant of I. G. Farben, higher acetylenes consisting of methyl acetylene, ethyl acetylene, vinyl acetylene, diacetylene and some higher homologues were produced in the ratio of about one part per ten of acetylene itself (*14*). Similarly in the partial oxidation of methane (Sachse Process) and in the Wulff direct pyrolysis process, higher acetylenes are produced. To date, no commercial use has been made of these compounds.

F. O. Rice and T. A. Wall (*15, 16*) have studied the pyrolysis of isobutylene and found that methylacetylene, allene and methane are formed during the reaction. Three recent patents (*17, 18, 19*) by Happel and Marsel describe the pyrolysis of isobutylene or tertiary butyl alcohol with steam to give a product stream containing substantial amounts of methyl acetylene and allene. The process is shown in Figure 1 and described briefly below.

The isobutylene or vaporized *t*-butanol is diluted with steam and is sufficiently superheated to prevent condensation in the lines before reaching the gas fired pyrolysis furnace. The furnace consists of a coil of Inconel or stainless steel of sufficient length to bring the reactants up to the desired reaction temperature of 850-1050°C and to provide sufficient contact time at the reaction temperature to give the desired conversion. Optimum contact times using the alcohol as the feed range from 0.05 to 0.5 sec; in the case of isobutylene, optimum contact times are 0.1-10 sec. The exit gas from the reactor, consisting of allene, methyl acetylene, methane, and other contaminants is rapidly quenched by the injection of hot water or steam directly into the pipe, cooling the methyl acetylene and allene to temperatures at which they are stable. Following the rapid quench to 425-480°C., the gases are further cooled, and the water and heavy tars are partially condensed out in a spray cooler. Removal of the major portion of the water and cooling of the gases to 38°C is carried out in the gas cooler and dehumidifier. The gas leaving the cooler contains only a small amount of water (about 3% by weight).

The gaseous product enters what may be referred to as the purification section. In this section the gas mixture is compressed to 325 lb./sq. in. gauge by means of a two stage compressor equipped with an intercooler. The gas is then liquefied by cooling to 45°F in a heat exchanger. The coolant for this exchange can be water which may be cooled to the desired temperature by evaporative cooling or by an ammonia or other compressed vapor systems.

Substantially all the hydrogen and a major portion of the methane and ethane are removed from the liquid stream by flash evaporation. The vapor stream leaves the vaporizer, and the gases may be used as fuel for the pyrolysis furnace. The liquid stream is sent to the accumulator.

In the first distillation tower, methyl acetylene and isobutylene are taken off as a bottoms product while allene and lighter constituents are removed overhead. The allene may be separated by distillation and isomerized to methyl acetylene if desired.

The bottoms stream containing methyl acetylene and isobutylene leaves the first tower as a liquid and

flows into a second tower which is maintained at 100 lb./sq. in. gauge and 100°F at the top. Methyl acetylene in excess of 90% purity is taken off at the top, condensed and stored; isobutylene is drawn off as the bottom product and recycled to the pyrolysis furnace.

Liquid ammonia condensations

Substituted acetylenes can be prepared by the alkylation of sodium acetylide or substituted metallic acetylides. The alkylating reagents are usually alkyl halides. Alkyl bromides give the best results since they are more reactive than the chlorides but produce smaller amounts of amines than the iodides. Thus an 89% yield of 1-hexyne was obtained when 5 moles of sodium acetylide was allowed to react with 4.5 moles of *n*-butyl bromide over a period of 6½ hr. *(20)*.

Certain diynes can be prepared from sodium acetylide and an alkyl dihalide as shown:

$$\text{X-R-X} + 2\text{NaC}{\equiv}\text{C-H} \xrightarrow{\text{liq. } NH_3} \text{H-C}{\equiv}\text{C-R-C}{\equiv}\text{C-H} + 2\text{NaX}$$

Thus yields of nonadiyne in excess of 80% of theory may be obtained from pentamethylene bromide and sodium acetylide (*20*).

Dehydration of acetylenic alcohols

The dehydration of acetylenic alcohols offers a convenient method for the synthesis of acetylenic hydrocarbons. In general, the tertiary acetylenic alcohols dehydrate much more readily than the primary or secondary alcohols. Although the acetylenic alcohols may be made in several ways including condensations of aldehydes or ketones with acetylene in liquid ammonia, probably the best procedure from a commercial standpoint involves condensation of an aldehyde or ketone with acetylene or a monosubstituted acetylene in the presence of KOH. For instance acetylene and acetone condense according to the following equation:

$$\text{H-C}{\equiv}\text{C-H} + CH_3\text{-}\underset{\underset{\text{O}}{\|}}{\text{C}}\text{-}CH_3 \xrightarrow{\text{KOH}} \text{H-C}{\equiv}\text{C-}\overset{\overset{CH_3}{|}}{\underset{\underset{\text{OH}}{|}}{\text{C}}} - CH_3$$

Several alcohols of this type are manufactured and sold commercially by the Air Reduction Company.

Such alcohols are easily dehydrated by either vapor phase or liquid phase procedures. Thus isopropenylacetylene (methylvinylacetylene) is prepared by dehydration of the alcohol listed in the above equation.

$$\text{H-C}{\equiv}\text{C-}\overset{\overset{CH_3}{|}}{\underset{\underset{\text{OH}}{|}}{\text{C}}} - CH_3 \xrightarrow{-H_2O} \text{H-C}{\equiv}\text{C-}\overset{\overset{CH_3}{|}}{\text{C}} = CH_2$$

Liquid phase dehydrations with aqueous sulfuric acid have been used with considerable success at the N. Y. U. laboratories. Vapor phase catalytic dehydration is also quite satisfactory.

A batch process for the preparation and dehydration of methylbutynol is shown in Figure 2, and described below.

The procedure of Bergman, Sulzbacher and Herman (*21*) as modified in the N.Y.U. laboratories is suited for the large scale preparation of acetylenic alcohols. This method utilizes the condensation of a carbonyl compound and a primary acetylenic hydrocarbon in the presence of KOH and an inert solvent. When acetylene is used as the hydrocarbon, it is desirable to use a solvent which absorbs a large amount of acetylene. Oxygenated compounds with the linkages -O-C-O- or O-C-C-O- such as ethylene glycol, ethyl butyl ether, and acetaldehyde dibutyl acetal are particularly good solvents for the reaction.

The reaction can be run on a commercial scale as follows:

Commercial grade KOH is added to three to four times its weight of acetaldehyde dibutyl acetal. The mixture is heated to 150-165° and agitated vigorously. The mixture is separated from any excess water which may be present and introduced into the reaction kettle where it is cooled to −10°C. During the cooling period vigorous agitation is maintained. The suspension is then saturated with acetylene.

Acetone is introduced at a rate which will maintain the reaction temperature at about −5°C. During this addition the feed of acetylene is adjusted to maintain a continuous venting of small amounts of acetylene from the reaction vessel. The addition of acetylene and agitation is continued for about one hour after all the acetone has been added.

The solid potassium derivative is hydrolyzed below 5°C by the addition of ice water. Agitation is stopped and the mixture is allowed to settle. The aqueous potassium hydroxide layer is removed and recycled to the reactor for dehydration and mixture with the solvent.

The organic layer is blown with carbon dioxide, and the potassium carbonate which is formed is removed by filtration. The organic layer is then distilled. Acetone is removed at atmospheric pressure. A methylbutynol-water azeotrope is also collected at atmospheric pressure. Pure methylbutynol is then removed under reduced pressure, and the acetal solvent is removed as a bottoms product and recycled. The bottoms contains tars and other products and must be redistilled periodically.

It is also possible to conduct the original condensation using a hydrocarbon as a solvent. If this is the case, it is possible to remove the organic layer after the hydrolysis and dehydrate the methylbutynol with an aqueous sulfuric acid solution. The organic layer from the dehydration reaction is distilled. Methylvinylacetylene is removed from the top of the

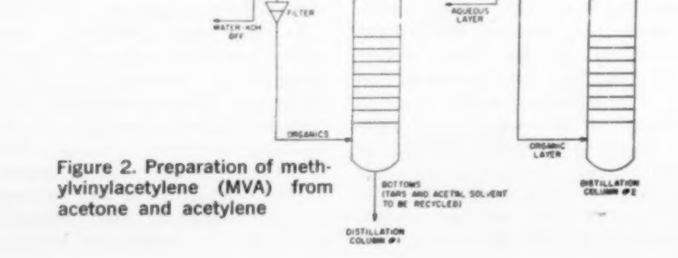

Figure 2. Preparation of methylvinylacetylene (MVA) from acetone and acetylene

Figure 4. Detonation studies 1, 2, 15.

column and the bottoms are recycled for use as solvent.

If the acetal has been used as the solvent, the pure methylbutynol and azeotrope are combined after distillation and dehydration.

Dehydrohalogenations

Acetylenic hydrocarbons can be prepared by the dehydrohalogenation of aliphatic dihalides. Recently a patent was issued for a process for the dehydrohalogenation of propylene chloride and chloropropene (*22*). It is claimed that the reactions proceed smoothly at 170°C in a solution of NaOH and the monoethyl ether of ethylene glycol to give methyl acetylene.

$$H\text{-}\underset{Cl}{\overset{H}{C}}\text{-}\underset{Cl}{\overset{H}{C}}\text{-}CH_3 \text{ or } H\text{-}\overset{H}{C}{=}\underset{Cl}{C}\text{-}CH_3 \xrightarrow[EtOCH_2CH_2OH\ +NaOH]{170°C} H\text{-}C{\equiv}C\text{-}CH_3$$

It is also possible to carry out dehydrohalogenations in the vapor phase, and it has been claimed that methylacetylene can be prepared by silica catalyzed vapor phase dehydrohalogenations of dichloropropanes and chloropropenes *(23)*.

Carbide decompositions

A preparation of propyne from Mg_2C_3 and absolute alcohol is the subject of a patent (*24*); this method was used by the Germans during the war for small scale preparation of propyne.

Dimerization of acetylenic compounds

The dimerization of acetylenic compounds offers a convenient means of preparing products with high degrees of unsaturation. An illustration of this is the formation of vinylacetylene from two molecules of acetylene, as practiced commercially by the Du Pont Company:

$$2\ H\text{-}C{\equiv}C\text{-}H \rightarrow H\text{-}C{\equiv}C\text{-}\overset{H}{C}{=}\overset{H}{C}\text{-}H$$

A more general procedure for the preparation of dimers of acetylenic compounds is oxidative coupling.

A process has been developed in these laboratories which utilizes the air oxidation of an aqueous solution of an acetylenic compound, ammonia and cuprous chloride:

$$R\text{-}C{\equiv}C\text{-}H \xrightarrow[NH_4Cl]{Air,\ CuCl} R\text{-}C{\equiv}C\text{-}C{\equiv}C\text{-}R$$

General properties of acetylenic hydrocarbons

Certain other properties which are associated with handling characteristics of a potential fuel are of considerable importance; these include storage, shock stability, toxicity, and compatability with various materials of construction.

Storage stability

Deterioration during storage is mainly caused by polymerization and peroxidation. As with many unsaturated hydrocarbons, acetylenic compounds are capable of polymerizing on standing, but they vary considerably among themselves in this respect. Acetylene will only polymerize in the presence of a catalyst. Other monoynes exhibit similar behavior. Cyclopropane and its alkyl derivatives are quite stable. Although the unconjugated diynes are quite stable, the presence of multiple bonds in conjugation usually decreases the stability of the compounds. Thus diacetylene (1,3-butadiyne) and vinylacetylene are quite reactive and polymerize more rapidly than butadiene. It has been noted that the presence of substituent groups can affect to a considerable degree the tendency of a compound to polymerize.

Use of inhibitors to retard the polymerizations of various acetylenic materials has been investigated in these laboratories. In general it can be stated that the storage stabilities of many acetylenic materials can be considerably improved by the use of the appropriate inhibitors. Two compounds which have been found to be particularly effective are *t*-butyl catechol and hydroquinone.

Shock Sensitivity

Two methods have been used to measure the shock sensitivity of hydrocarbons; the mechanical impact test, and sensitivity to a detonation blast. A mechanical impact tester, Figure 3, suggested by the Shell Development Company (*25*) was used by N.Y.U. for most of the sensitivity studies. It consists of a steel ball which is dropped on a piston that adiabatically compresses the fuel in a small cylinder (the apparatus is actually a small diesel fuel injector). The test indicates whether a compound will detonate under the prescribed conditions but does not rate a non-detonating compound. A procedure to rate non-detonating compounds was developed in which the tester is used to determine the quantity of a shock sensitive material required to be added to an acetylenic compound to cause detonation of the mixture.

The shock sensitive additive material (referred to as peroxy butane) was obtained from The Shell Development Company. Its composition is about 86% 2,2-bis (tert-butyl peroxy) butane and 14% di-tert-butyl peroxide.

The Shell impact tester is essentially a modified 5-mm Bosch diesel injection plunger, fitting into a cylinder containing three drops of the sample to be tested. (The standard plunger, which has a spiral groove at its base, was replaced by a plunger having a 1-mm conical cavity at its base.) A 44-gram steel ball is dropped through the pipe to the plunger from a height of 5 ft. The vapor trapped in the cavity of the plunger is compressed adiabatically and temperatures of the order of 400-500°C may be produced. This would be a sufficiently high temperature to initiate an explosion if the liquid were unstable. For samples sensitive to this type of impact, detonation occurs, and the ball is ejected from the pipe.

A second method was used, based on the Becco test for hydrogen peroxide detonation (*26*), in which the test material is subjected to the extreme shock of a detonating blasting cap. In this test the test material is placed in a 15 x 150 mm Pyrex test tube. A number 6 electric blasting cap is lowered into the test tube so that it is half immersed in the fuel. The test tube is then placed in an upright 7 in. section of ¾ in. lead pipe having ¼ in. wall thickness (AA grade), supported on a mandrel in a 1 in. thick steel plate. The blasting cap is then deto-

nated. Several distinct types of results were observed when using this testing procedure, Figure 4.

1. **No Detonation**—For example: detonation #1, for hexane. The lead pipe was broken, but not in two separate pieces. The shattering effect was probably due to the transmittal of the shock of the blasting cap by the inert liquid. Excess liquid remained after the blast.
2. **Detonation**—For example: detonation #2 for peroxy butane. The lower half of the lead pipe was shattered into many small fragments, and the upper half was recovered as a single distorted piece. In this case, the shattering effect was caused by the more or less *complete* detonation of the liquid under test. No excess liquid was recovered.
3. **Partial Detonation**—For example: detonation #15 for a 90% peroxy butane/10% hexane mixture. In these cases, the lead pipe was broken into two separate pieces, and each half recovered as a distorted section. The shattering effect is postulated to be caused by the detonation of the liquid in the immediate vicinity of the blasting cap; however, the liquid does not sustain a propagated detonation wave, and therefore will not detonate completely. In nearly all cases of this type, excess liquid was noted.

When a pure liquid achieved complete detonation, or partial detonation, it was diluted with hexane* (in 10% increments) until the *no detonation* level was reached. In this manner, a measure of relative instability was sought.

When a pure liquid produced no detonation, it was diluted with peroxy butane until the *partial detonation* level was reached. In this manner, a measure of relative stability was sought.

*Hexane was used as the inert control. Hexane was believed to be sufficiently stable so as to undergo absolutely no decomposition when subjected to the shock of a detonating blasting cap.

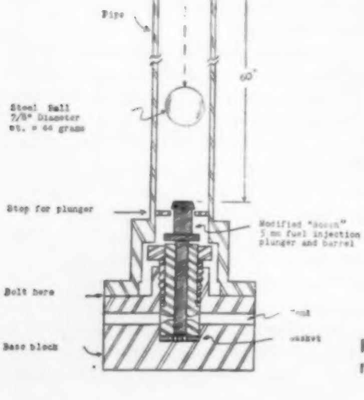

Figure 3. Mechanical impact test apparatus

In general there was good agreement between the results obtained by the two series of tests, and it appears that the shock sensitivity of fuels can be evaluated by either procedure.

Only limited data are available on the toxicological properties of certain acetylenic hydrocarbons. The toxicity of a typical acetylenic hydrocarbon was determined on mice by the intragastric and respiratory route; the local irritant properties were determined by instillation into a rabbit's eye.

The compound was observed to produce artificial sleep (hypnosis or narcosis) in mice. The testing indicated a very slight irritative activity of the compound, and this agrees with previously reported studies in which butadiene, isoprene and other related compounds were said to cause irritation of mucous membranes of eye and respiratory tract.

Using the system of classification of Hodge and Stemer (1949) the ALD value (Approximate Lethal Dose) following oral administration of the compound indicates that it has a rating of "slightly toxic." The industrial hazard resulting from handling of the compound would appear to lie in its action as a hypnotic and narcotic agent. Prolonged breathing of high concentrations would result in irritation of respiratory passages as indicated by results on related compounds.

Corrosiveness

In general, it may be said that these hydrocarbons are not corrosive to common metals. However, it must be recalled that acetylene can form metallic salts of copper, silver, and mercury which are potentially explosive. If the compound does not contain a terminal acetylenic hydrogen, these salts cannot form. Acetylenic hydrocarbons have been kept in contact with steel, aluminum, and yellow brass at 75°C for 32 days with no apparent damage.

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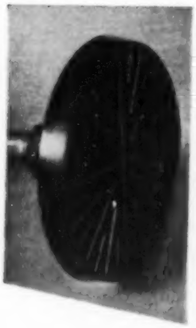
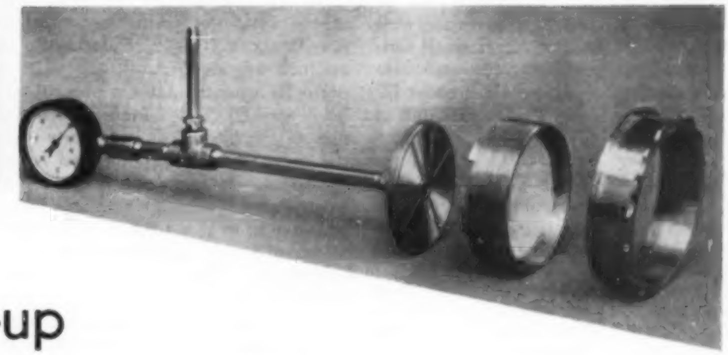


Figures 1, 2, 3—Oliver vacuum precoat test leaf at left; Standard Oil test leaf in center; exploded view of Dicalite precoat filter test leaf at right.



Precoat scale-up from lab-size filter test leaf

Reliable precoat filtration scale-up data, formerly unobtainable on laboratory-scale filters, can be determined quantitatively on the test leaf described here. New refinements permit accurate measurement of the precoat filter layer thickness.

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ROTARY VACUUM PRECOAT FILTERS have been in use for many years and their industrial application is continually becoming more wide-spread. To investigate some variables affecting vacuum precoat filtration, several manufacturers of these filters have built small-scale testing devices. One of these is a one-tenth square foot test leaf made by the Dorr-Oliver Company (Figure 1).

This leaf consists of a plastic support upon which a filter cloth is stretched and supported by a clamping ring. The ring holds the cloth by friction on the conical surface of the plastic support.

In operation, vacuum is applied to this device; then by immersion in a slurry of filter aid, a precoat of the desired thickness is built up. After precoating, the leaf is immersed in the liquid to be tested. The flow of the liquid through the precoated leaf is recorded for any given time. The surface of the precoat, which has become plugged, is cut off with a knife to repeat this test. While this device is quite useful, it is impossible to obtain accurate information on the economics of the filtration operation because the minimum knife cut required cannot be determined.

Another piece of equipment constructed for small-scale testing was made by the Standard Oil Company of Indiana. It used a double aluminum ring attached by friction to the outside of the Oliver leaf. This design is shown in Figure 2. This ring has a micrometer thread permitting the user to change the height of the outer ring to some extent. In this manner the leaf can be precoated and cuts made with some degree of accuracy. The principal disadvantage of this type of equipment is that its construction does not allow an accurate cut to be made over the entire surface of the precoat. In addition, temperature changes or careless operation can cause the friction-fitted ring to move on its support, which disturbs the precoat and impairs the accuracy of cut.

A simple, vacuum precoat test leaf

Until the development of the precoat filter test leaf with controllable shave-off, no laboratory-scale test device had been available for the study of process variables in precoat filtration. The test device described has proven well suited for the study of the effect on filtration rate of the type of filter aid, the depth of knife cut, drum rotation, and other variables. Excellent correlation on filtration rate and filter-aid usage has been found between this device and production scale filters.

A complete study of major process variables can be completed in a few hours with a relatively small volume of slurry. Test data are presented for seven industrial liquids showing correlations between filtration rates on the new test leaf, on a pilot-plant-scale precoat filter, and on full-scale production filters.

The authors are in the technical department, Mining and Mineral Products Division.

which can obtain accurate data on vacuum filtration was developed by Dicalite Dept. Data accumulated to date with this test leaf correlate well with results obtained on a small Oliver vacuum precoat filter and also with results on plant-scale precoat filters. An exploded view of this unit is shown in Figure 3.

Description of test leaf

The Dicalite vacuum precoat test leaf consists essentially of three parts: a one-tenth square foot septum support with a grid of concentric and radial grooves permitting drainage toward a central outlet which is connected to a delivery line fitted with a vacuum gauge; a retaining ring, internally threaded to permit screwing onto the support and externally machined to 20 threads/in. (This ring has a narrow shoulder which holds the filter cloth, or screen, tightly against the supporting surface by means of a gasket); and an outer ring threaded over a relatively small part of its inner surface to permit screwing it onto the retaining ring. This outer (cake ring) is graduated in 5 thousandths of an inch. A full turn of the cake ring on the retaining ring represents 50 thousandths of an inch.

Operating procedure

In actual use the leaf is precoated with the lowest slurry concentration of filter aid practical under the conditions to be tested. After sufficient precoat thickness is obtained (about 1¼ in.), the leaf is removed from the filter aid slurry and allowed to dry under vacuum. At this stage, the cake is cut with a suitable knife, taking progressively smaller cuts until the surface of the cake is even with that of the retaining ring. Several additional cuts of 10 to 20 thousandths of an inch are made until the cake is perfectly smooth. After a precoat has been applied in this manner, the liquor to be filtered is substituted for the precoat slurry and the leaf is immersed in it, removed, and allowed to dry under vacuum at a cycle corresponding to that used in plant operation, or deemed appropriate in a new application. The vacuum is disconnected at the end of the drying cycle.

It should be noted that the knife cut is made at atmospheric pressure. This is somewhat different from the normal operation of a rotary vacuum precoat filter in which the knife cut is made at a reduced vacuum. It is difficult to determine the exact vacuum accurately when the cake is cut. It would also be cumbersome to try to adjust the vacuum on the laboratory test leaf to the simulated reduced value at the moment of cutting. Furthermore, the cutting operation on the test leaf is somewhat different from that taking place on a full-scale filter.

There is a definite, although small, amount of expansion and contraction on a precoat subjected to a variable vacuum. The permeability of the cake is greatly increased when the partially plugged surface is cut. This results in a lowered vacuum on the remaining uncut cake and thus causes it to expand. On a rotary vacuum precoat filter this takes place immediately following that point at which the cut is made with the result that the vacuum beyond that point is reduced and a slight amount of expansion takes place over the entire width of the filter drum. The reduced vacuum does not materially affect the surface of the drum which is submerged or which is drying because of the partition of the drum into a number of segments. The test leaf, however, has no such segments, and if the cut were to be made under vacuum, it would be reduced progressively while the cut across the cake is being made with the result that the first part of the cut is made at a higher vacuum than the remainder of the cut. This would cause a progressive swelling of the cake and the cut would start at the nominal amount and would increase considerably beyond that amount as the cutting operation progresses.

The actual filtration operation is run through 5 to 10 cycles, depending upon the filtration characteristics of the liquor. At the end of the proper number of cycles the volume of filtrate is measured. After each cut the surface of the filter cake is examined to determine whether a major part of the cake shows a clean surface. If two successive series of 5 to 10 cycles each result in approximately the same volume of filtrate, it can be assumed that the surface of the filter cake is not being progressively plugged, and that

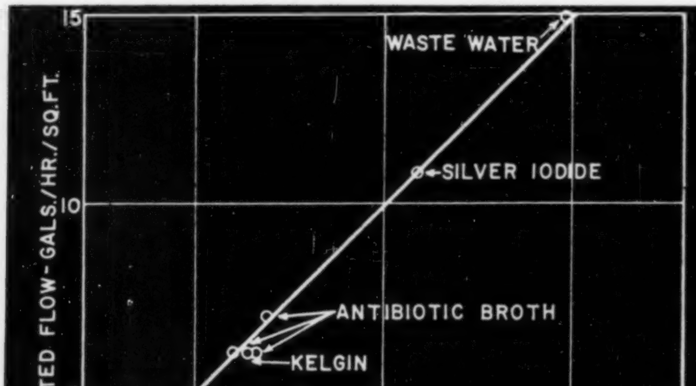


Figure 4—Correlation between vacuum precoat test leaf and plant-scale filter.

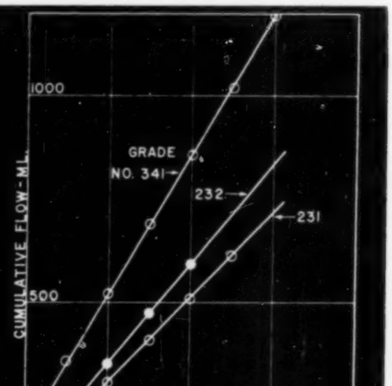


Figure 5—Influence of different types of filter aids.

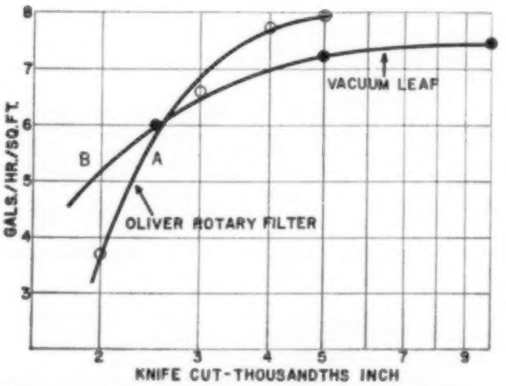


Figure 6—Effect of knife cut on flow rate for the same liquor (see Figure 5).

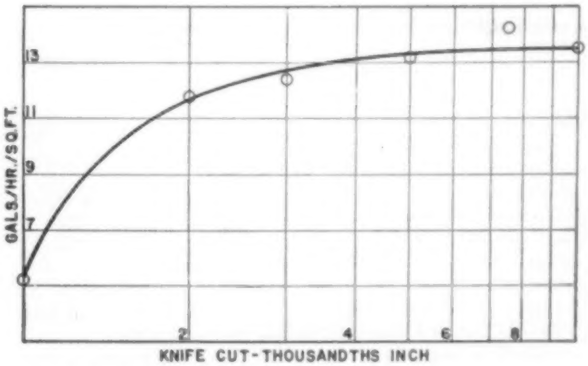


Figure 7—Influence of knife cut on rate of flow obtained with the vacuum test leaf.

a shallower cut may be tried. If the flow of liquor through the cake decreases from one series to the next, it is obvious that the cake is plugging and that either a deeper cut or another grade of filter aid should be used.

In this manner different grades of filter aids and different operating conditions can be evaluated. Figures 4 to 9 show typical results obtained by the use of the vacuum precoat test leaf. It will be noted in Figure 4 that the flow rate predicted by means of the leaf was, in most cases, very close to actual results. Operating conditions such as knife cut, submergence, and rotational speed were the same with the test leaf and actual plant conditions for all the points shown.

The liquor used to obtain the data of Figure 5 was the raw material for the production of carotene. In actual plant practice it is filtered on a rotary vacuum filter. The manufacturers of this material considered that it would be highly desirable to increase the filtration rate. Tests run on the vacuum test leaf indicated that of all the filter aids tested, three showed particular promise. Under identical filtration conditions the flow rates obtained with these three filter aids were as follows:

341—5.4 gal./(hr.)/(sq.ft.)
231—3.2 " " " "
232—3.8 " " " "

These results point up the considerable variation in the flow that can be obtained under the same operating conditions using different grades of filter aid.

Data shown in Figure 6 are only of relative value and demonstrate the influence of the knife cut in a filtration operation. This figure shows that the flow decreases rapidly when the depth of cut is decreased substantially below 0.005 in. A depth of cut of more than 0.005 in. does not materially increase the flow, but does increase the cost of operation. Curve A represents data obtained on a small laboratory-size rotary precoat filter and Curve B represents the vacuum leaf. The rate of flow with both coincided at approximately 0.0025 inches cut. Data shown in Figure 6 (obtained on the same liquor as those shown in Figure 5) cannot be compared directly because the tests were run several days apart with a change occurring in the quality of the liquor filtered. This deterioration of the liquor caused a considerably higher rate of flow under osten-

TABLE 1—Dicalite 1000 W
1/2 rev./min.
50% submergence, 22 in. Hg vacuum, 180°F.

cycles	*cut*	*% cut*	*ml.*	*gal./hr. sq. ft.*	*gal./min. 250 sq. ft.*	*lb. filter aid 100 gal.*
1-5	0.010	100	275	4.36	18.2	11.4
6-10	0.005	45	185	2.93	12.2	8.5
11-15	0.005	70	215	3.41	14.2	7.3
16-20	0.0025	5	103	1.64	6.9	7.6

TABLE 2—Dicalite 372
1/2 rev./min.
50% submergence, 22 in. Hg vacuum, 180°F.

cycles	*cut*	*% cut*	*ml.*	*gal./hr. sq. ft.*	*gal./min. 250 sq. ft.*	*lb. filter aid 100 gal.*
1-5	0.010	100	348	5.51	23.0	9.1
6-10	0.005	60	268	4.25	17.7	5.9
11-15	0.005	95	310	4.95	20.5	5.1
16-20	0.0025	30	175	2.78	11.6	4.5

TABLE 3—Dicalite 372
1 rev./min.
50% submergence, 22 in. Hg vacuum, 180°F.

cycles	*cut*	*% cut*	*ml.*	*gal./hr. sq. ft.*	*gal./min. 250 sq. ft.*	*lb. filter aid 100 gal.*
1-5	0.010	100	198	6.27	26.2	15.9
6-10	0.005	90	188	5.95	24.8	8.4
11-15	0.005	95	193	6.12	25.5	8.2
16-20	0.0025	35	121	3.82	16.0	6.5

Notation

cycle: filtration cycle on rotary filter equals one full revolution. Filtration cycle on Dicalite leaf denotes immersion of leaf in liquor, drying under vacuum and cutting of filter cake.
cut: depth of knife cut in inches.
% cut: estimated percentage of clean surface area of filter cake after cut.
gal./(hr.)/(sq.ft.): gallons of filtrate collected in 1 hr. for 1 sq.ft. filtering area.
lb. filter aid/100 gal.: lb./filter aid consumed in filtering 100 gal.
c.d.: dry density in lb./cu.ft. of filter cake on rotary filter after shrinkage.
submergence: percentage of filter drum diameter below liquid level.

. . . specific experimental examples compare various test filtrations obtained

sibly the same conditions.

For the data of Figure 7 a raw sugar solution containing activated carbon was used as the test medium. Here again, a depth of cut greater than 0.005 in. did not substantially increase the rate of flow. At cuts below that depth, the flow through the filter decreased rapidly.

It will be noted that Figure 8 shows an almost constant increase of the rate of flow with increased knife cut up to a depth of 0.01 in. The purpose of the tests on the Williamson clarifier scums was primarily to determine the most economical operation conditions for this operation. In addition it provided data for the influence of knife cut in another medium. Tables 1, 2, and 3 present data obtained when testing these scums in the customer's plant with the test leaf.

Tables 1 and 2 show the difference between results obtained with two different filter aids, all other operating conditions being equal.

Table 3 shows the influence of rotational speed on filtration performance of a rotary filter as measured with the Dicalite test leaf. In a comparison of Table 3 with Table 2, it will be seen that a .005-in. cut appeared to be the minimum practical. With the faster rotational speed there was a definite increase in flow rate through the filter but also a substantial increase in filter aid consumption to an average of 8.3 lb./100 gal.

The data plotted in Figure 9 were also obtained with the vacuum precoat test leaf. In this case a 50° Brix raw sugar solution was used.

What can be determined in the laboratory

1. Size of rotary vacuum filter for new installation
2. Type, grade, and quality of filter aid
3. Amount of body feed
4. Depth of knife cut
5. Flow rate
6. Clarity of filtrate
7. Effect of rotational speed
8. Effect of submergence
9. Effect of vacuum
10. Effect of temperature
11. Operating costs

Examples

The following examples (A to E) compare various test filtrations obtained with the vacuum precoat test leaf and the performance of rotary filters in actual plant practice. Examples F and G compare data obtained with the test leaf and that obtained with a laboratory model Oliver vacuum precoat filter.

A. Waste water sludge filtration using filter aid A*.
Filtration conditions: 2 min./rev.; 33⅓% submergence; 90°F; 22 in. Hg; 0.001 in. cut.
Predicted flow rate with leaf–14.9 gal./(sq.ft.)/(hr.)
Actual flow rate–14.8 gal./(sq.ft.)/(hr.)

B. Antibiotic broth filtration using filter aid B*.
Filtration conditions: 1 min./rev.; 45% submergence; ambient temperature; 18-20 in. Hg; 0.006-in. cut.
Predicted flow rate with leaf–7 gal./(sq.ft.)/(hr.)
Actual flow rate–6.9 gal./(sq.ft.)/(hr.)

C. Sugar scum filtration using filter aid A*.
Filtration conditions: 2 min./rev.; 50-55% submergence; 175-180°F., 20-22 in. Hg; 0.004-in. cut.
Predicted flow rate with leaf–4.37 gal./(sq.ft.)/(hr.)
Actual flow rate–5.32 gal./(sq.ft.)/(hr.)

D. Antibiotic broth filtration using filter aid A*.
Filtration conditions: 1 min./rev.; 30-50% submergence; ambient temperature; 15-18 in. Hg; 0.006 in. cut; 215% body feed.
Predicted flow rate with leaf–6.05 gal./(sq.ft.)/(hr.)
Actual flow rate with 500 sq. ft. Oliver–6-6.6 gal./(sq.ft.)/(hr.)

E. Pineapple juice filtration using filter aid C*.
Filtration conditions: data not available.
Predicted filter aid consumption with leaf–50 lb./1000 gal.
With 8 X 12 ft. Oliver–50 lb./1000 gal.

F. Silver iodide filtration using filter aid A*.
Filtration conditions: 1 min./rev.; 50% submergence; ambient temperature; 27 in. Hg; 0.008-in. cut.
Predicted flow rate with leaf–10.8 gal./(sq.ft.)/(hr.)
Laboratory Oliver–10.9 gal./(sq.ft.)/(hr.)

G. Kelgin filtration using filter aid C*.
Filtration conditions: 85 sec./rev.; 50% submergence; 160°F.; 28 in. Hg; 0.005-in. cut.
Predicted flow rate with leaf–6.02 gal./(sq.ft.)/(hr.)
Laboratory Oliver–6.40 gal./(sq.ft.)/(hr.)

* filter aid A = Dicalite Speedplus
* filter aid B = Dicalite 372
* filter aid C = Dicalite 757

Presented at A.I.Ch.E. meeting, Seattle, Washington.

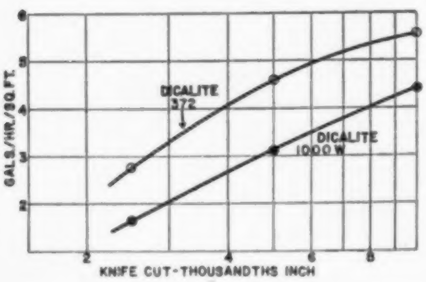


Figure 8—Influence of knife cut on sugar scums from a Williamson clarifier.

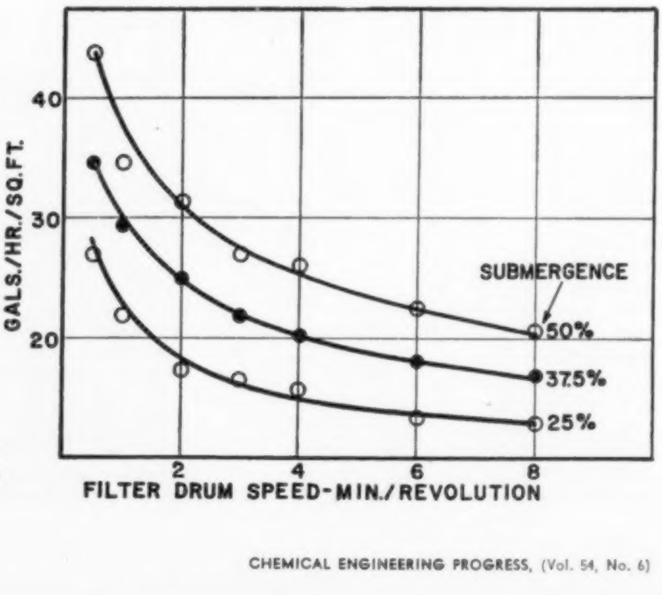
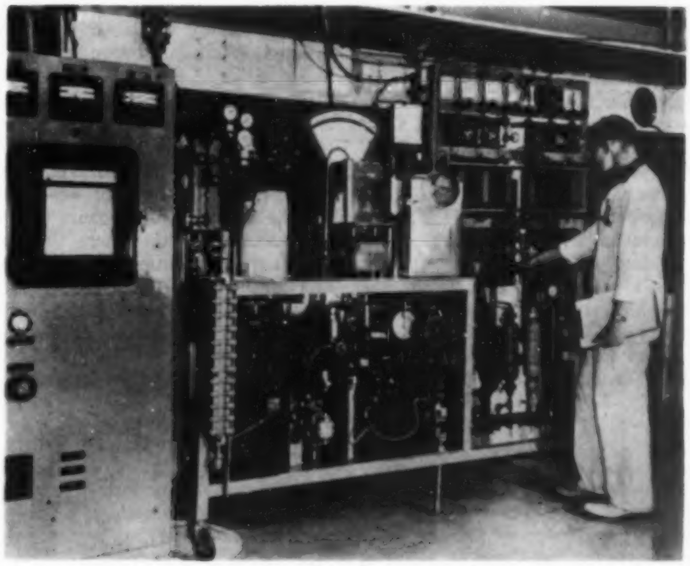


Figure 9—Effect of different drum speeds and submergence on a rotary vacuum precoat filter.

Scale-up of radiation effects

E. J. Henley,[1] N. F. Barr,[2]
S. Thomson,[3] and E. R. Johnson[4]

The effects of atomic radiation on chemical systems are a function of the rate and mode of energy transfer. Some important investigations have been made to determine the relationship between radiation effects and rate of energy transfer.



Radiation effects—pilot plant used by Esso Research and Engineering at Brookhaven National Laboratories, Upton, New York. In small-scale operations at Brookhaven and at Esso in Linden, New Jersey, it was found that radiation in basic refining reactions, thermal cracking, greatly increases rate of gasoline production.

VARIABILITY OF RADIATION effects with quality and intensity of radiation poses an important problem for engineers. One aspect of the problem is radiation damage. For instance, ample data are available on the rate of decomposition of water with gamma radiation. An engineer designing a homogeneous reactor must know whether these data can be used in sizing an oxygen-hydrogen recombination unit under conditions where neutron, electron, and fission product radiation rather than gamma predominates. Similar problems arise in scale-up of processes, involving chain reactions such as chlorinations and polymerizations. If the lifetime of a radical is greater than 10^{-8} sec., track overlaps will occur even at moderate dose rates. Thus there will be acute effects of dose rate as well as linear energy transfer on product quality and rate of reaction.

Linear energy loss (LET) is the average energy loss per centimeter of track. This will vary between wide limits depending on the energy and quality of the radiation. A half Mev. electron will deposit about .02 ev./A°; a .05 Mev. electron .07 ev./A°; while a one Mev. alpha particle dissipates energy at a rate of 26 ev./A°. This energy dissipation by ionization occurs discontinuously along the track of a particle. Figure 1 illustrates the relative track density of electrons and alpha particles *(1)*. At each point of ionization, the secondary electrons promote further ionizations of the medium.

For the medium water, the primary events following the ionizations have been chronicled. Within 10^{-11} sec. after a primary event, the water will have decomposed, into radicals:

$$H_2O = H + OH$$

Four radicals of each species are deposited as a cluster in a "hot spot," Figure 2A *(1)*. These clusters are, of course, separated by 1,000 A° for the case of 0.5 Mev. electrons, while for an alpha particle, they will overlap.

If one looks at this "hot spot" 10^{-7} sec. after the primary event, Figure 2B, it will be noted that the hot spot will have expanded due to diffusion, and that some reactions, i.e., $2H = H_2$, $2OH = H_2O_2$, and $H + OH = H_2O$, have taken place.

This radical-diffusion model has been quite effective in predicting the linear energy transfer effects *for non-chain reactions* in liquid systems. It predicts an independence of the reactions on radiation intensity since an intensity which would give tracks separated by less than 20A° is not yet achievable. In the case of chain reactions where radical life is measured in seconds rather than microseconds and less, the tracks *will* overlap, even at moderate radiation intensities, and a dose rate dependence will most certainly be observed.

These points are exemplified and elaborated in the following discussions, which also illustrate the usefulness and applicability of the radical-diffusion model to systems not in the liquid state.

Liquid state

The yields of radiation-induced chemical reactions in solution are found experimentally to depend on the rate of energy loss of the radiation. This observed variation in yield with rate of energy loss for several systems may be used to calculate the

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. . . new work reveals discrepancies in previously accepted results in the field.

individual radical and molecular product yields for each type of radiation. By writing expressions for the observed yields or *G* values (molecules reacted/100 ev. of absorbed energy) in terms of the yields of radical and molecular products, one obtains a series of simultaneous equations which can be solved for the individual yields for each type of radiation.

A tabulation of these yields for radiations ranging from Co^{60} gamma-rays to the heavy particle recoils from the B(*n, a*) reaction in 0.8N sulfuric acid solutions is shown in Table 1 *(2)*. The initial rate of energy loss of these radiations varies from 0.02 ev./A° to ≈ 25 ev./A°.

It is seen from the table that with increasing rate of energy loss there is an associated decrease in the yields of the radicals H and OH and a corresponding increase in the yield of molecular products. According to the radical diffusion model, interspur reactions increase with increasing rate of energy loss since the interspur distances become smaller. Thus molecular products are produced not only as a result of diffusion from a spur but as a result of the overlap of diffusion from adjacent spurs.

Along with the increased yield of molecular products one sees that there is a decreased yield of water decomposition as the rate of energy loss increases. This quantity is a measure of the detectable dissociations of water into either radical or molecular products and is expected to decrease along with increased radical-radical reactions as a result of hydrogen-hydroxyl radical reaction to reform water.

Thus the radical diffusion model appears to account quite satisfactorily for reactions in aqueous solutions of simple inorganic systems. The model is apparently capable of accounting for the behavior of organic systems in aqueous solution where the chief reaction is oxidation. All of these reactions, except for a few, proceed with *G* values approximately equal to the yield of water decompositions, that is, a few molecules/100 ev. absorbed.

TABLE 1.—DECOMPOSITION OF 0.8 N SULFURIC ACID SOLUTIONS

Radiation	−(dE/dx) in units of (ev./A°)	Radical and molecular yields*				
		G_H	G_{OH}	G_{H_2}	$G_{H_2O_2}$	G_{H_2O}
Co^{60} γ-radiation (2-Mev. electrons)	0.02	3.65	2.95	0.45	0.80	4.55
18-Mev. deuterons	0.52	2.39	1.75	0.71	1.03	3.81
8-Mev. deuterons	1.0	1.71	1.45	1.05	1.17	3.80
32-Mev. helium ions	2.25	1.28	1.06	1.14	1.25	3.56
B^{10} (*n, a*) Li recoils	25	0.23	0.41	1.66	1.57	3.54

* In the absence of dissolved oxygen.

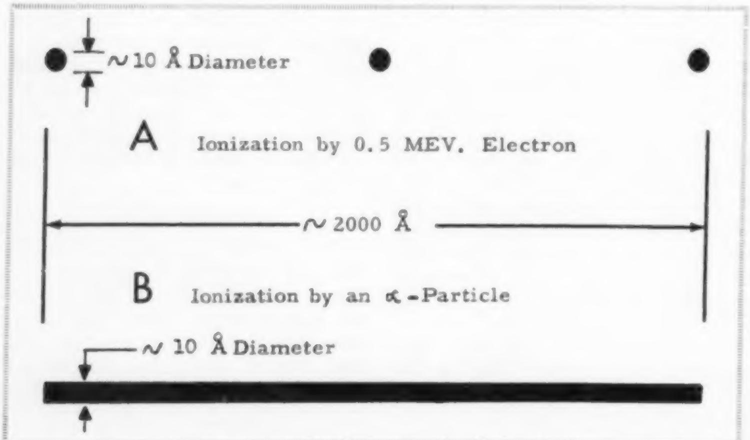

Figure 1. Relative track densities of electrons and α-particles. A. electrons. B. α-particles.

In the case of liquids other than water a radical diffusion model is less easily formulated. The first difficulty is the obvious one, that for complex molecules the initial product distribution is more complex than the hydrogen and hydroxyl radical observed in the case of water. Radical production in irradiated hydrocarbons has been examined with the aid of scavenger techniques by Schuler *(3)* and others. Here again total radical yields of 5-10 radicals/100 ev. are observed. The complexity of the initial radical spectrum increases with the molecular weight of the irradiated liquid. The spectrum of products does, however, appear to be independent of dose rate. A complete study of the effect of rate of energy loss on the radical distribution has not been made. It has been found, however, that the hydrogen yields from cyclohexane irradiated with 2 Mev. electrons and 35 Mev. alpha particles, are essentially the same *(4)*.

Recent investigations have indicated difficulties with the simple radical diffusion model. In Table 1, it is seen that the net water decomposition yield decreases, as is to be expected, with increasing rate of energy loss due to increased hydrogen-hydroxyl radical back reaction in passing from Co^{60} γ-rays to 40 Mev. deuterons. As the rate of energy loss is further increased, the net water decompositions remain constant while the radical yields are decreasing. On the basis of the simple, radical diffusion model this means that hydrogen-hydrogen and hydroxyl-hydroxyl reactions are occurring while hydrogen-hydroxyl reactions are not. Initially, since nothing was known about the hydroxyl radical yield, it was thought that this might be explained by the hydroxyl radical yield going to zero before the hydrogen atom yield. Since this is not the case, it becomes necessary to postulate either a different distribution of hydrogen and hydroxyl radicals or, as suggested by Allen, to assume that the yield of water decompositions is higher in the dense tracks of heavy particles due to self-scavenging of radicals.

An even more important discrepancy is indicated in recent work by Miller *(5)* and Hart *(6)*. Molecular oxygen is indicated as a primary product of water radiolysis, the yield of oxygen increasing with increasing rate of energy loss. Thus, it becomes necessary to account for the reaction of radicals with molecular products in the spurs and tracks.

Finally, some recent investigation casts suspicion on the hydrogen radi-

cal itself as a primary product in the radiolysis of water. The reducing species formed in the radiolysis of water has been shown by various investigators to react with oxygen and hydrogen peroxide with equal facility. The species which is produced by the reaction of hydroxyl radical with hydrogen, which might be thought to be the hydrogen atom also, has a strong preference for reaction with oxygen over hydrogen peroxide. This indicates these radical species are different and that at least one of them is not the hydrogen radical.

These difficulties do not however detract from the usefulness of the radical diffusion approach in predicting the effects to be expected in extrapolating and interpolating radiation effects data in the liquid state.

Solids

Three different types of solids may be considered: organic, metals, and inorganic solids.

Organic solids usually mean polymers, and certainly the radiation chemistry of these materials has been exhaustively investigated. In general, one might conclude that changes such as cross-linking, degradation, and loss of mechanical properties are, to a large extent, independent of dose rate and linear energy transfer. This is to be expected since diffusion through a solid is so slow that the radical diffusion model is inapplicable.

Metals, alloys, and semiconductors have been the subject of extensive studies. A bibliography in this field would include more than 1000 references *(7, 8)*. In general, an incoming particle may do one of three things: it may undergo an elastic collision with one or more of the orbital electrons; it may collide elastically with the nucleus itself; or it may transmute the nucleus in an inelastic collision.

Elastic collision with either electrons or the nucleus may occur. The former will produce no observable change in a metal although in the case of insulators it may displace electrons into a conduction band. If the collision is with a nucleus, a vacant lattice site and an interstitial atom are produced. If the incoming particle has a high energy, either the recoil atom or incident particle may undergo further collision with sufficient energy to knock atoms on. This kind of effect is, of course, dependent on both LET and type of irradiation. A 2 Mev. neutron, for instance, will produce about 6000 displacements in aluminum, whereas a 5-Mev. alpha particle will produce only 60, and a 20-Mev. proton 80 *(8)*.

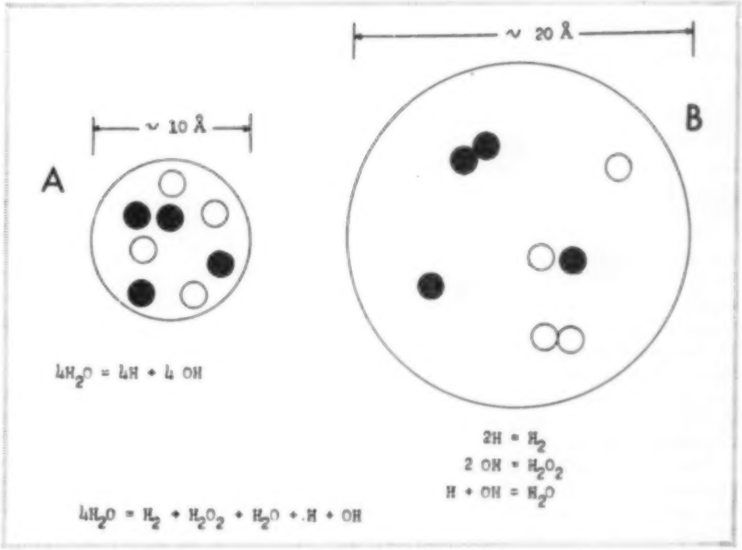

Figure 2. Dissociation and recombination in "hot spots." A. radicals deposited as a cluster. B. "Hot spot" expanded owing to diffusion.

One would expect little or no dose rate dependence. Due to the low diffusion, the damage will be grouped around the locale of the first collision. In Cu_3Au, for instance, the volume affected by one neutron is estimated to have a diameter of about 100 A°.

A most interesting phase of radiation effects in solids is the work now going on with inorganic crystals. Sodium chloride, for instance, becomes blue if salt is irradiated under conditions such that the temperature does not rise appreciably, and it is found that the color saturates, i.e., an increase in radiation (dose) will not make the color more intense. Dissolution of the irradiated salt in water yields the following reaction:

$$NaCl^* + 2H_2O = H_2 + OH^- + HOCl + Na^+$$

(*Denotes an irradiated species)

Indications are that both free sodium atoms and free atoms are present; these are referred to as electron excess and electron defect centers respectively. The *G* value for the above reaction is extremely low (about 0.01-0.001). Ferrous sulfate on the other hand is radiation labile.

Solution of irradiated ferrous ammonium sulfate in deaerated water yields ferric ion, sufite ion and hydrogen.

$$2Fe^{2+} + 2H_2O = 2Fe^{3+} + H_2 + 2OH^-$$

$$2Fe^{2+} + 2H^+ + SO_4^= = 2Fe^{3+} + SO_3^= + H_2O$$

The *G* values are 1.8 for Fe^{3+}, 0.43 for $SO_3^=$ and 0.35 for H_2.

Unlike ferrous sulfate, manganous sulfate is susceptible to radiation and does not yield sulfite ion on irradiation. Solution of irradiated $MnSO_4 \cdot H_2O$ in water yields manganic ion and hydrogen. Why the sulfate ion is resistant to radiation in this salt is not known.

One of the interesting problems is to determine exactly to what extent reaction has occurred in the lattice. In the case of the nitrates, the available information indicates that the reaction has occurred completely before dissolution of the salt. To clarify this statement, an explanation of the general experimental procedure is useful. The experimental procedure in the study of these salts is to dissolve the irradiated sample in deaerated water in a vacuum system and determine the gases evolved. Other chemical changes such as nitrite formation, are determined on a separate sample. The question arises, for instance in the case of nitrate decomposition, are the nitrite ion and oxygen formed on interaction of the irradiated salt with the solvent, or are they formed in the lattice? Potassium nitrate under radiation decomposes to yield nitrite ion and oxygen

$$KNO_3 = KNO_2 + \tfrac{1}{2} O_2$$

Magnetic susceptibility measurements *(9)* on the irradiated crystal indicate that the oxygen is present in the lattice as a molecule. Heats of solution of the irradiated salt substantiate the conclusion that NO_2^- exists in the crystal as such, and not as some metastable precursor.

However, with respect to other salts

such as the sulfates just discussed, this may not be the case. Oxidation and reduction both may be due to trapped electrons in the crystal reacting with the water.

The *G* values of the various nitrates are appreciably different. The reason for this is not definitely known, principally because detailed knowledge on many of these salts is not available. It has been postulated that the *G* values of the various nitrates is proportional to the free volume in the crystal. However, this idea is not consistent with all the available facts.

The decomposition of some other nitrates is not quite as simple as that for KNO_3. Evidence has been obtained which indicates that lead nitrate decomposes as follows:

$$Pb(NO_3)_2 \rightarrow Pb + 2\ NO_2 + O_2$$

Under continued radiation the lead "back-reacts" with the oxygen in the crystal to yield the oxide

$$Pb + \tfrac{1}{2}\ O_2 \rightarrow PbO$$

The stoichiometric ratio of NO_2/O_2 is reduced from the initial value of 2:1 with continued radiation, etc. Since large pressures of oxygen can be built up in the lattice (as high as 80 atm.), and furthermore, since there is good evidence for back-reaction occurring, it would appear that free volume consideration would not enter significantly into the yield (*G* values) of nitrate decomposed. By this is meant that there is ample opportunity for oxygen and nitrite ion to back-react in the KNO_3 but apparently it does not. Another suggestion to account for the variation in yield of the nitrates has been made by Hochanadel and Davis *(11)*.

Gas phase

The chemical changes resulting from radiation were first interpreted to be the reaction of ions on neutral molecules through the intermediary of ion-clusters. This view required that in reactions where many molecules reacted per ion pair, large ion-clusters had to occur. This idea was accepted until it was shown on theoretical grounds that large ion-clusters were unlikely.

At about this time radical chains were being discovered in chemical reactions. In many cases the radical chains seemed to offer a better explanation for the large *G* values than did large ion-clusters. Furthermore, it was shown that the number of radicals produced as a result of ionization and subsequent neutralization per ion, adequately accounted for the product yield. The role of ions was that of initiating radicals and the products of these reactions were similar to those produced by similar radical-molecule reactions. While there were differences in product yields in systems induced by photolysis and radiolysis, these differences were usually attributed to experimental conditions.

We are now in the process of re-evaluating this concept. Consider, for instance, the hydrogen-deuterium exchange reaction which is known to have a long chain length. If this reaction proceeded by way of ions, impurity gases which reduced only the concentration of the ions would reduce the yield. If however the reaction proceeded by way of atoms, such impurity gases would have little effect on the product yield. It was found that those gases whose ionization potentials were lower than hydrogen reduced the product yield as much as three orders of magnitude, while these same gases did not affect the yield at all when the exchange reaction was carried out under conditions involving atoms only, e.g., the thermal and photochemical reactions. The suggestion that ions can be chain carriers was then advanced and is presented as

$H^{2+} + H_2 \rightarrow H_3^+ + H$ initiating reaction

$H_3^+ + D_2 \rightarrow H_2D^+ + HD$ chain carrying reaction

$H_3^+ + (-) \rightarrow H_2 + H$ termination reaction

That ion-molecule reactions such as the chain-carrying step (above) occur in the early stages of radiation reactions has been evidenced in the radiation of methane. The difficulty of explaining the product yields by the conventional radical reaction mechanisms has led to a reconsideration of ion-molecule reactions. This reconsideration has been greatly helped by the study of the rates of ion-molecule reactions in a mass spectrometer and a comparison of these rates with those of atom processes.

In the irradiation studies of methane, by the use of both the mass spectrometer and the product yields from radiation experiments, it is possible to determine both the specific rate constants for the individual reactions and the over-all reaction. This technique has permitted a more careful choice to be made between ion processes and atom processes in this radiation induced reaction.

The initial steps propose an ion-molecule reaction mechanism *(12)*

$$CH_3^+ + CH_4 \rightarrow C_2H_5^+ + H_2$$
$$CH_4^+ + CH_4 \rightarrow CH_5^+ + CH_3$$

While methyl ions and methyl radicals are both present in the reacting system, the rate of the ion reaction is so much faster than the atom reaction that radicals do not compete with ions. The yield of any product is thus limited by the mean life of the ions.

The mean life of the ions is determined by the mean time required to diffuse to the wall or be neutralized in the gas phase. As ions react on every collision, the mean life must be larger than the time between collisions in order to have ion-molecule reactions.

In general the *G*-values of gas phase radiation reactions are not changed by the intensity of irradiations. As one might expect, the diffusion in the gas phase is so rapid that the radical-diffusion model gives way to homogeneous kinetics. The *G*-value is expected to increase with pressure since the ions will be making more collisions in diffusing to the wall. If however the ions are neutralized in the gas phase, the increase in the *G*-value may not occur with a change in pressure.

The ion-molecule reactions studies so far do not show any appreciable activation energy so it is not expected that temperature will seriously affect the *G*-value.

ACKNOWLEDGMENT

The authors wish to acknowledge the help and suggestions of O. A. Schaeffer.

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Interconnected pilot plant - laboratory system

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Dow Corning Corp., Midland, Mich.

Described here is the development of a corridor-connected pilot-plant laboratory-office system. The advantage of making face-to-face communication simple between people having a wide variety of functions is stressed.

BECAUSE TIME IS REQUIRED for the growth of markets, the number of products in the development stage at Dow Corning increases each year, as shown in Figure 1. During such expansion, the pilot plant is involved in two main phases:

Initial scale-up from the laboratory. The primary concern is to get a product that duplicates the samples previously made in the laboratory. At this point the commercial value of the material may not be definitely known. The larger quantity is made to allow a more complete evaluation by the application groups or by potential customers. For this reason, close proximity of the pilot plant to the product engineering evaluation laboratory is desirable.

Process improvement. Frequently improvement in the product is required during market development. For this purpose the process is usually modified as well. If, and when, production is to be increased, then an entirely

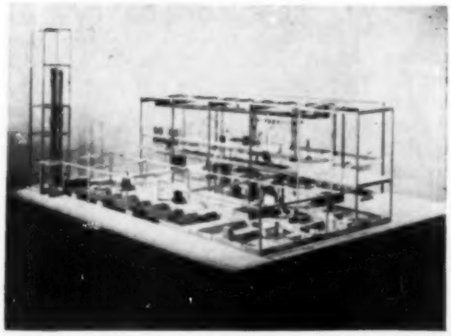


Figure 3. A scale model of pilot plant.

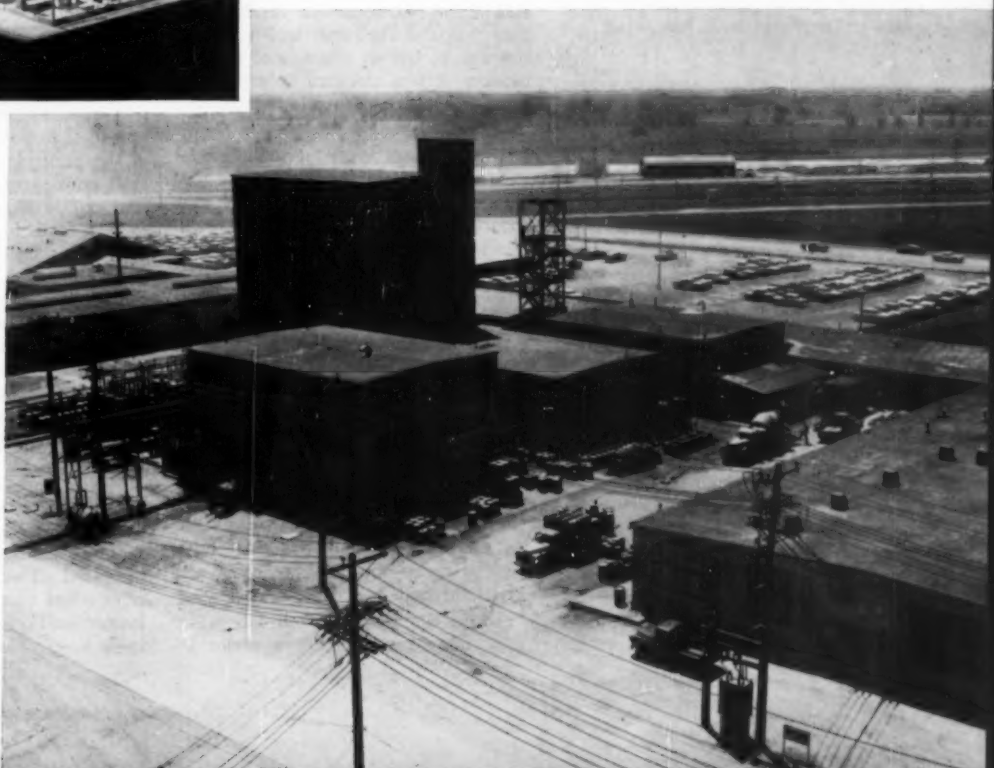


Figure 2. Current group of pilot plant buildings.

. . . the problems in replacing old pilot plant

new process may have to be developed to attain desired costs. For example, in the development of one product, five different units were built and operated before the final plant design was made.

At the time the main pilot plant units were built, facilities were needed to conduct three main types of pilot plant work:

1. Silicon chemical process development work, including some high-temperature and high-pressure reactions.
2. A wide variety of distillation problems—involving mainly chlorosilanes—many of these requiring either good columns, high temperature, or both.
3. Facilities for converting silicon chemicals to silicon polymers by removal of the chlorine from the chlorosilanes, usually by hydrolysis with water.

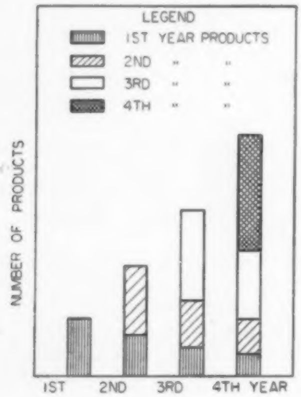


Figure 1. Cumulative increase in numbers of products with time.

Replacing old pilot plant

The following account, which describes the pilot plant built during 1948 to 1952 to provide these facilities, will present the shortcomings of these relatively new units, and show how a new chemical pilot plant to replace the original one was designed and built.

Because of the wide range of distillation problems, it was decided to set up a distillation service building with equipment ranging in size from 20- to 1,000-gal. stills. The distillation problems on chlorosilanes, in particular, would require high vacuum and high-temperature heating as well as atmospheric pressure distillation.

It was believed that such an establishment would train skilled operators and competent still supervision to provide valuable distillation service—not only to the pilot plant but to the production and research departments as well. Because of the complexity of numerous distillation problems, extensive studies of various dumped column packings over a period of years have been made. For example, they have proved that McMahon screen saddles are useful in columns up to 6-in. diam.

In Figure 2, the center of the three buildings was the first hydrolysis plant, built in 1948. Aside from the fact that this building was small for the work that was soon required of it, it now seems a mistake to have included laboratory space in the building. The space might better have been used for pilot plant equipment, since an adequate laboratory was to be located right across the court in the adjacent building.

When the second hydrolysis building in the left foreground was built in 1952, the height was raised 12 ft. to give better process space for chemical development work. Since that time valuable continuous processes have been developed in this building and it is now completely filled with equipment.

The chemical pilot plant building on the right was almost out in the country when it was built. There were no buildings to the left of it and there was no office near by. However, it is now surrounded by other activities. The bomb racks for high-pressure work are in the lean-to at the right end of the building. One small explosion that did no harm took place in this space, but as a result of the explosion, it was decided to move the whole operation to a safer place.

In planning a new facility for chemical pilot plant work, a scale model (Figure 3) was of great use. The value may be judged from the fact that the model was almost completely redesigned and rebuilt three times before the plans were finally approved.

Its facilities include an eight-cell high pressure enclosure with access from a corridor that also serves as a control room. The individual high pressure cells are 6 x 12 ft. enclosures fabricated on three sides and ceiling from double thicknesses of 3/8-in. boiler plate spaced approximately 3 in. apart. The fourth side consists of a full area blowout wall of plastic sheeting. The blowout wall faces out on an open area over 500-ft. deep with a spray pond for cooling water at its far end.

In developing this whole laboratory pilot plant arrangement a major attempt was made to make communications between research people and others as easy as possible. It seemed this could be done best by using connecting corridors between buildings wherever possible. This interconnected system, as it now stands, makes it easy for many people to see each other face to face.

The rapid growth of the silicone industry made the limitations of these facilities soon evident, and new plans had to be made to meet future needs more fully.

The accompanying series of illustrations (Figure 4) shows how the schematic plan evolved.

Buildings numbered (1) are the original ones constructed in 1945 to house the general shop and stockroom for the whole plant, plus the analytical and research laboratories and pilot plant.

Buildings numbered (2) include the pilot plant group built in 1948-52, plus the first major laboratory addition. The shop and stockroom space became the electrical industry product engineering laboratory, and the original research and pilot laboratory became all analytical.

Buildings numbered (3) show how the further additions surrounded the pilot plant group. (Note area shop which provides maintenance service for the laboratories and pilot plants.)

Buildings numbered (4) show the more recent additions to the pilot plant and laboratory system; also shown is the space (5) that remains available for future laboratory addition.

Practical lessons of experience

Some lessons learned from this laboratory pilot plant development are:

A good locker and lunchroom were provided in addition (4) to take care of the pilot plant operating crew. But shift employees did not care to walk 250 or 300 ft. along a closed corridor to rest and lunchrooms during rest periods, and an additional small restroom had to be provided in the immediate pilot plant area.

The point has now been reached where pilot plants can no longer be connected by corridors to the system for lack of space. Only enough room is left for a laboratory to accommodate about 150 more people. The main early mistake was in planning the width of the block back of the main corridor. It would have been just as easy to make the building distance 250 or more feet instead of the 160 ft. provided. Then the laboratory and pilot plant corridors could have been longer and much more space could have been provided around the pilot

plant units.

Because more intermediate scale production work is now being required from these facilities than was expected, inadequate space was provided for tank and drum storage. This was overcome in part by the addition of the pilot plant warehouse in group (4).

The 40- x 60-ft. pilot plant buildings (2) were built too small. At the time of construction it was thought desirable to separate various operations for safety reasons. Separate buildings for different types of work are still preferred, but they are now being built 80 x 80 or 80 x 100 ft. Based on early experience with the first hydrolysis building, headroom in such process development pilot plants is at least 12 ft. from floor to floor.

The still building has provided the service for which it was designed. However, one thing is lacking—adjoining space for process work. There is a tendency to use the costly floor space in a high building like this for related process work that does not require the headroom. A two-story addition to this building is required to reserve the headroom for stills.

The establishment of the area shop in group (3) provided a significant improvement in the maintenance and servicing of pilot plant and laboratory operations. The shop is manned by a design engineer, a maintenance engineer, a maintenance foreman, and a crew of tradesmen, who are always at the service of the pilot plant and research people. It took several years to make clear that research laboratories and pilot plants need such a service in order to take them out of competition with production for general shop service.

Originally it was not intended to connect offices to this laboratory system, but when addition (3) was built, it was connected to the main corridor. This has made two-way communications easier in all kinds of weather between laboratory people and many others in the whole management organization.

Besides providing for better and easier personal communications, corridors have the added advantage of providing cover for all kinds of services. Experience with this corridor-connected laboratory and pilot plant system proves it is an excellent arrangement for the management of a great variety of interrelated work because it provides such easy access of people to various facilities and services and to each other.

Presented at A.I.Ch.E. meeting, Chicago.

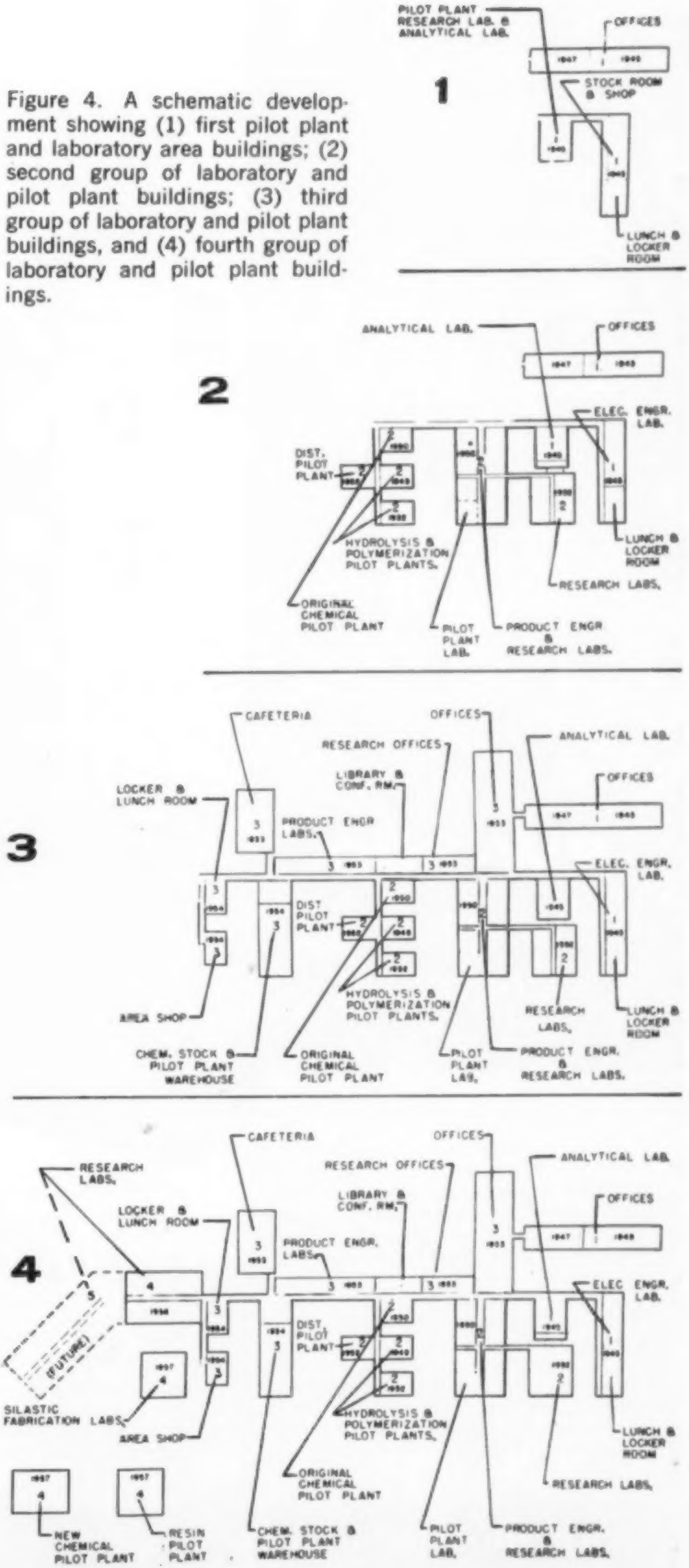
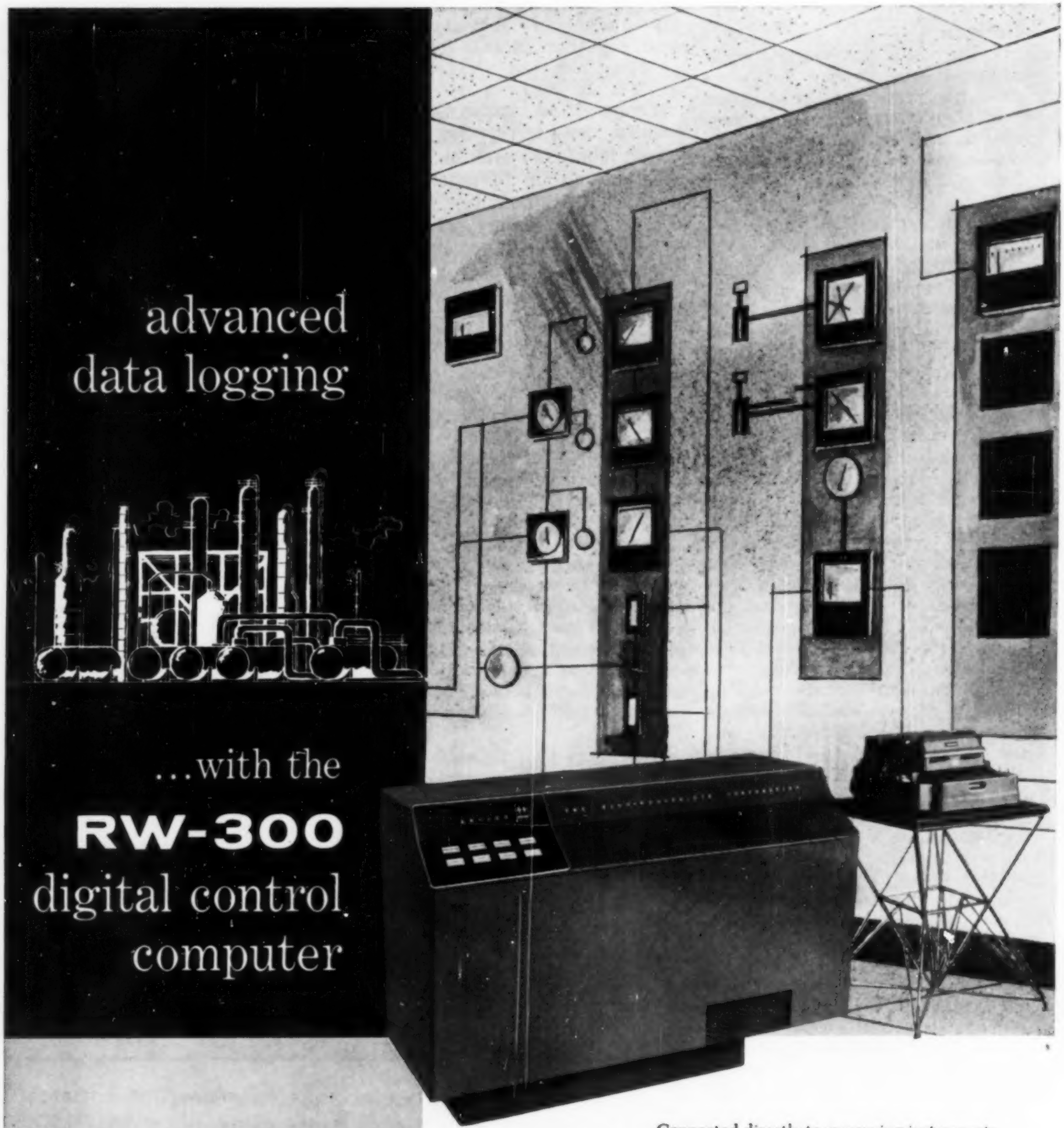


Figure 4. A schematic development showing (1) first pilot plant and laboratory area buildings; (2) second group of laboratory and pilot plant buildings; (3) third group of laboratory and pilot plant buildings, and (4) fourth group of laboratory and pilot plant buildings.



The Ramo-Wooldridge RW-300 Digital Control Computer—the first digital computer designed specifically for automatic on-line process control and data logging—offers significant advantages as the heart of advanced data logging and scanning systems for oil refining, chemical, and other process industries. Unlike conventional data loggers, the RW-300 can be converted to completely automatic control through a minor field modification without purchasing expensive additional equipment and without scrapping any part of the existing logger.

Connected directly to measuring instruments, the RW-300 can do more than log raw or partially processed data. It can also compute and immediately print out more meaningful information such as yields, conversion efficiencies, and energy balances. The RW-300 can also calculate operating guides for plant personnel to follow. In addition to checking process variables against upper and lower limits, the RW-300 can perform more sophisticated checks on process equipment and the process itself. These checks reduce plant maintenance costs by detecting faulty operation of the process in time for corrective action.

For technical information on automatic process control and advanced data logging with the RW-300, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P. O. Box 45067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

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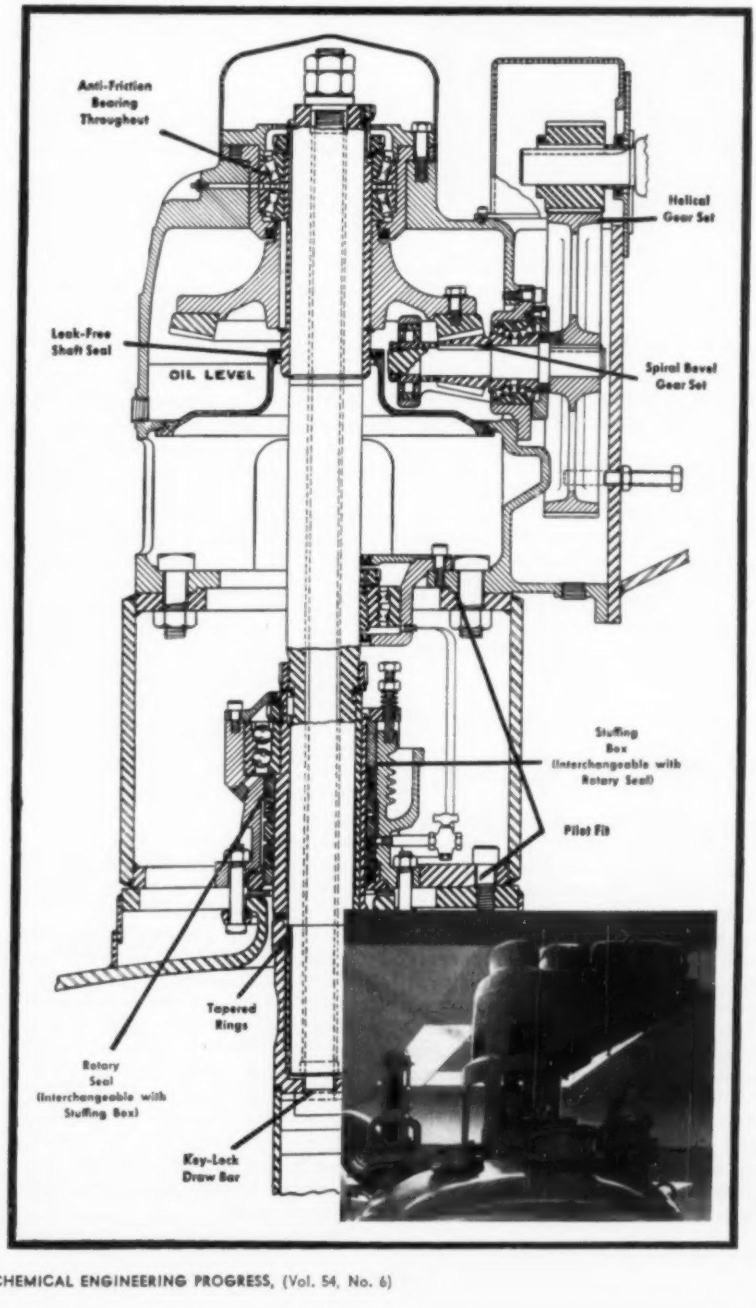

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Its soft hum is the sure sign of a machine constructed to run week after week without once faltering or stopping for repairs.

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Get perfect alignment in minutes. Notice that the pedestal mount is *keyed* to the drive unit with a pilot fit. The pad mount is *machined* level at the factory. Then the drive is made to fit the mount just one way—the right way. You'd have to work some *not* to get perfect alignment every time.

Squeeze more life from a drive. Only two bearing areas support the BH Drive's shaft. This gives much wider bearing spread. Naturally that means less run-out, less chance of shaft whip. Seals last longer. Alignment is maintained all the time. The critical agitation speed is increased 50% over previous design. And, you can use a longer shaft without inserting a step bearing.

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See also Chemical Engineering Catalog, pages 1407 through 1418.

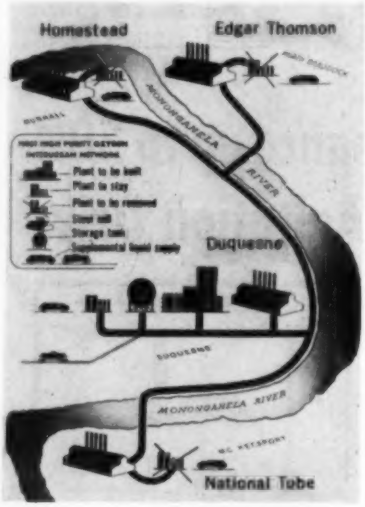
Largest on-site oxygen plant

New 1,000 ton a day "captive" plant, being built by Linde Co. (Union Carbide), will be the largest on-site oxygen plant, will serve four U. S. Steel works by pipelines.

The rapidly growing use of oxygen in the process of making steel is the major factor behind Linde's construction of this giant plant at a time when general business conditions have prompted much postponement of expansion plans.

The use of oxygen in steelmaking has gone up from some 30 cu. ft./ton in 1930 to an average of 200 cu. ft./ton today. About half of this is used directly in steelmaking processes, and the other half in standard operations such as scarfing, cutting, scrap preparation, etc. But metallurgical uses are expected to take and hold the lead since oxygen use has become a low cost alternative to building additional furnace capacity to meet increased demand.

The new plant's 1,000 ton/day capacity is equivalent to 730 million cu. ft. of 99.5 percent pure oxygen a month, will serve the needs of four U.S. Steel plants on the Monongahela River south of Pittsburgh. These are the Homestead, Edgar Thomson, Duquesne, and the National Works, National Tube Division. The plant will



Linde's new plant and pipeline service for U.S. Steel's Monongahela steel works.

be located at the Duquesne Works, will distribute its oxygen to the other three by pipeline. Expansion to include a fifth plant, Carrie Furnaces, is probable.

Capacity already installed at Homestead, Edgar Thomson and National Works will be dismantled and replaced by the new plant. Since all oxygen plants must be shut-down for periodical thaw-out and maintenance operations, Linde will bring in "Driox" liquid oxygen by tank car and tank truck to supply U.S. Steel's needs during these shutdowns.

Cyanamid builds multi-million dollar plant

New plant of American Cyanamid will produce anthraquinone, will also be the only commercial producer of napthquinone in the country, will use a new process developed by the company.

Located at Bound Brook, N. J., the new unit is to be operated by Cyanamid's Organic Chemicals Division, will replace and expand existing anthraquinone facilities.

In addition, the new plant provides additional production capacity for methyl anthraquinone and phthalic anhydride. When the plant is completed it will also produce napthoquinone—the only commercial producer of this material in the country.

An outdoor continuous processing installation with panel-board control, the new plant is planned to cover some two acres. Cyanamid's Engineering and Construction Division will supervise the design and construction. Completion is expected in late 1959.

The new process is known as the napthoquinone process and involves the direct oxidation of napthalene in a fixed bed catalytic converter. It has been in the process of development for six years, has been successfully operated in pilot plant scale operations.

Radioisotopes aid Esso develop new gasoline

Radioactive tracers, ultra-violet, and a new additive result in new premium gasolines at Esso. The new fuels are low in engine-deposit-forming aromatics, deliver similar performance at lower octane ratings.

A three and a half year, $750,000 research project at Esso's Linden, N.J., Research Center, has resulted in the introduction to the market of a new premium gasoline formula used in the top two grades of Esso's fuels. Reason: Esso admits it is expensive to add octane numbers, cost to consumer goes up, much power is wasted when deposits demand higher octane than motor really needs.

Crux of the new formula is removal of heavy, high boiling aromatics. By using radioisotope Carbon 14, Esso pinpointed what types of hydrocarbons were forming power-stealing combustion deposits in engines. These turned out to be the heavy, high boiling aromatics. With ultra-violet analysis, Esso determined exactly which aromatics were present in its gasoline.

At a relatively small cost of $1 million, Esso made changes in its refining processes and gasoline formula to essentially remove the harmful aromatics leaving a cleaner gasoline. Primary in these changes were closer fractionation and the use of more selective feedstocks. There have been no basic changes in Esso's refining processes.

Esso found that by simply removing the heavy aromatics it got a gasoline very nearly as good as highly expensive "clean" gasoline.

But removal of the deposit-forming aromatics does not solve all problems, and Esso has also developed a new additive to solve the residual deposit problem. Called a combustion control agent, the additive is really two compounds, one of which contains phosphorous—a departure for Esso which has steadfastly opposed phosphorous additives. The company is saying nothing more about its additive at this time, except to claim that it does not raise spark knock.

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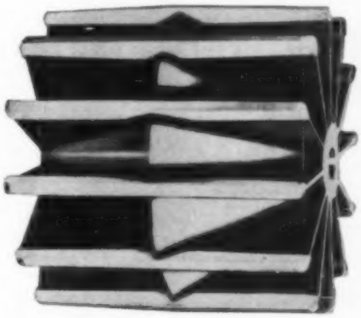

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Bore Length	Extra long to reduce shaft stress—$3\frac{1}{4}$" bore length for $2\frac{7}{16}$" shaft	Short bore—2" bore length for $2\frac{7}{16}$" shaft
Ribs	Fewer ribs needed because belt contact area is greater	Extra ribs required, this means less space for large pieces to discharge. Greater possibility of damage

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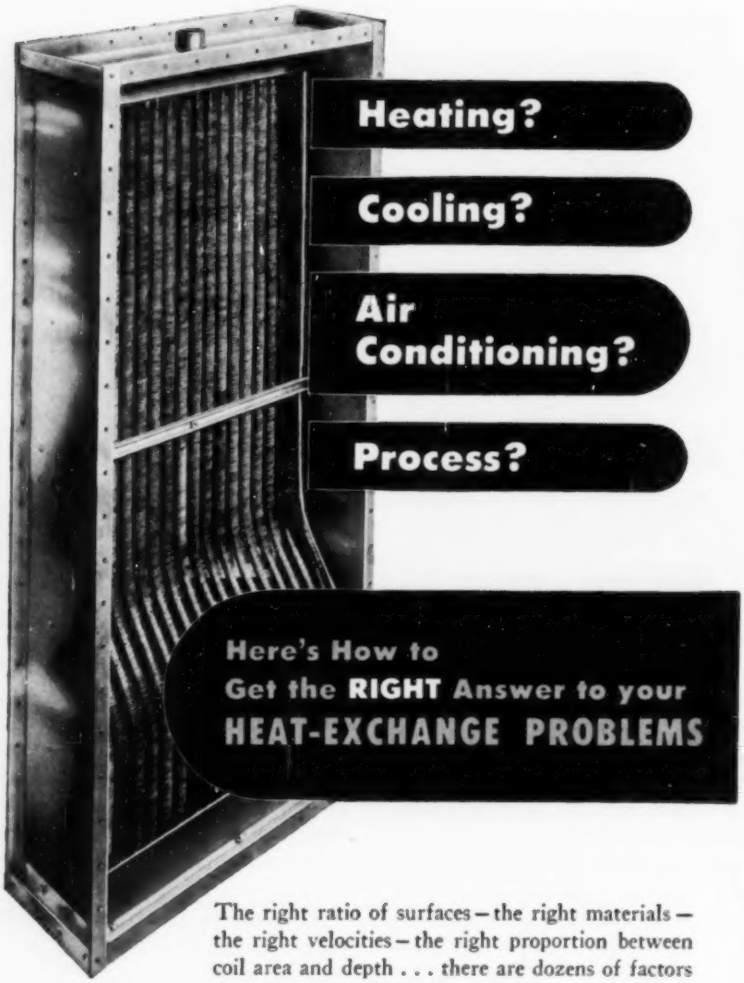

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A second edition of "A Rational Approach to Air Pollution Legislation" has been published by MCA. The booklet, originally issued in 1952, defines the precepts and principles essential to air pollution legislation, and outlines step-by-step procedures for formulating such laws. The booklet points out that each local air pollution problem is usually unique, and, for that reason, should be controlled by residents of the individual communities. The chemical industry, which spends some $40 million a year on air pollution abatement, authorized MCA to establish an Air Pollution Abatement Committee in 1949. #

The Bart Manufacturing Corp., Belleville, N. J., has enlarged its facilities for the nickel cladding of steel plate, sheet, heads and fabricated shapes. The new facilities, which use the company's "Bart Lectro-Clad" process, will be able to clad steel heads up to 132 in. dia. by 3 ft. deep, sheet and plate 89 in. by 246 in., and 132 in. by 132 in., and shapes up to 60 in. by 144 in. Bart still maintains facilities for nickel lining by the Bart process pipe up to 20 in. dia. by 20 ft. random lengths. #

The Durez Plastics Division of Hooker Chemical has been decentralized, will now operate as an autonomous division of the company. #

Attention is directed to the efforts of the College Teacher Recruiting and Placement Sub-Committee of the A.I.Ch.E. Education Projects Committee. This Sub-Committee has surveyed the needs of schools and universities in the United States and Canada for teachers of chemical engineering subjects this coming September, and has published the results which are available from the Secretary of the Institute. See page 137.

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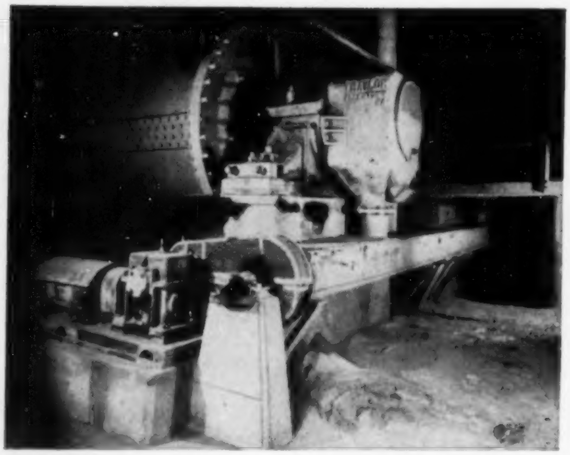

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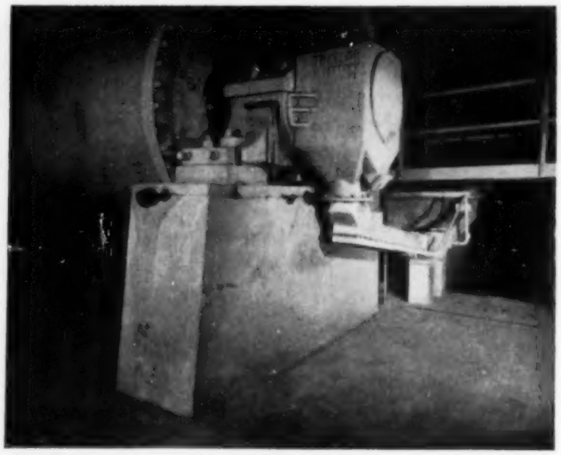

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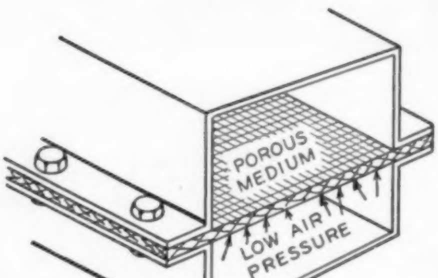

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106BL 106BR 107A 108L 109A 110L 111A 112-113A 114B
115A 116L 116R 117A 118L 118BR 119R 120L 120BR
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June, 1958

CEP

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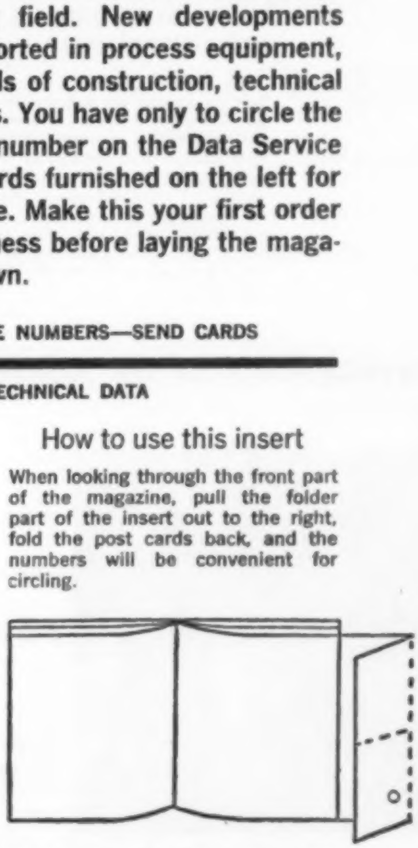
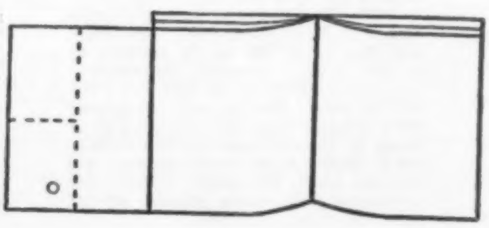


As you pass the pull-out page, and are looking through the back part of the magazine, pull the insert completely out to the left, and the numbers will again be in a convenient position for circling.



CEP Data Service

For action—results

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EQUIPMENT

328 Efficiency Recorder. Produces graphic recording of the utilization of a machine or of a process. Will read out accumulated percentages at any time. Data from Gorrell & Gorrell.

329 Vacuum and Pressure Gauge Bulletin. Includes price list on vacuum gauges, absolute pressure indicators, electronic manometers and flowmeters. Hastings-Raydist, Inc.

330 Construction Model Component Catalog. Designed to simplify construction planning of chemical and petrochemical plants, refineries, and equipment layout. F. Ward Harman Associates.

331 Two New Dehydrators. Small model has capacity of 500 to 1,000 lb./hr. of water; large model up to 36,000 lb./hr. Arnold Dryer Division, Hail Co.

332 Valve Catalog. Hoke, Inc. offers technical details of their 280 Series metering valves for 3,000 lb./sq. in. service, 1/16 or 1/8 in. orifice, in brass or stainless steel Type 316.

333 Packaged High-Vacuum Pumping Systems. Bulletin from Vacuum Equipment Division, New York Air Brake Co. gives specifications, performance data, ordering information.

334 New Steel Valve Design. Brochure from Kerotest Manufacturing Co. gives details of full-opening, double block and bleed, nonlubricated, optional flow valve with vapor-tight seal.

335 Universal Pilot Plant Filter. Designed for all vacuum filter applications. Available on monthly rental basis. Data from Komline-Sanderson Engineering Corp.

336 Pressure Gauge Catalog. Complete engineering data and selection tables for application to process plant instrumentation. 48 pages. Kunkle Valve Co.

337 Catalog of Indicating, Recording, Controlling Thermometers. Fifty-six-page catalog from Minneapolis-Honeywell Regulator Co. describes vapor-actuated, gas-actuated, and mercury-actuated thermometers and thermal systems.

continued on page 88

SERVICES

400 Acetylene Process Brochure. M. W. Kellogg offers description of Belgian process (SBA) for production of high-purity acetylene from natural gas or naphtha, or ot liquid feedstocks.

401 Reference File on Pickle Liquor covery. Process description and flow she from Blaw-Knox on the Blaw-Knox-Ruth process.

402 Brochure on Process Equipment F rication. Kennedy Tank & Mfg. offer bull on their fabrication facilities. Charts equipment lists.

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MATERIALS

301 Triethylborane. Callery Chemical announces availability of sample quantit for experimental studies. Bulletin gives te nical data.

302 Handbook on Methylcellulose Eth Physical properties, chemical compositi preparation of solutions, effect of additiv gelation of solutions, suggested uses. D Chemical Co.

303 Bulletin on Molybdenum Pentachlori Gives physical and chemical properti uses and applications. Climax Molybden Co.

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DESCRIPTIONS of products advertised in this issue

circle numbers on post cards

continued

IFC Dryers, Coolers, Calciners, Kilns. Bulletin 118 from C. O. Bartlett & Snow.

3R Data on Bulk Feeders. Bulletin from B. F. Gump on line of Draver feeders with automatic timing controls.

4A Entrainment Separators. Bulletin 21 from Otto H. York Co.

6BL Gauge Glass and Cylinders. Swift Glass Div., Swift Lubricator Co.

6BR Catalog of Kettles and Tanks. B. H. Hubbert & Son, Inc.

7A Heat Transfer Equipment. Bulletin 25C6177 from Allis-Chalmers.

8A Level Controls. Bulletin F4A from Fisher Governor gives details of Level-Trols.

9A Heat Exchangers. Design and fabrication services from Yuba Consolidated Industries.

10L Oil Reclaimer Systems. Bulletin R-160 from Hilliard Corp.

11A Plant Design and Construction. Lummus Co.

12L New Inventory Scale. Data from Thayer Scale Corp. on the Autoweightion.

13A Equipment Fabrication in Special Metals. Bulletin on Hortonclad from Chicago Bridge & Iron.

14A Graphite Heat Exchangers. Technical data from National Carbon Co.

18A Book on Steam Traps. Forty-four pages of engineering and selection data from Armstrong Machine Works.

19A Chemical Circulating and Transfer Pump. Bulletin 624A4 from Goulds Pumps.

21A Data on Absorption with Activated Carbons. Technical brochure from Pittsburgh Coke & Chemical.

22A Leakproof Pumps. No seals, no stuffing box, no packing. Data from Chempump Corp.

23A Split-Level Bowl Mixers. Technical data from Read Standard, division of Capitol Products Corp.

24L Surface Condensers and Steam Jet Ejectors. Consulting services from Graham Mfg. Co.

25A Miniature Valves. Data on many types from George W. Dahl Co.

26A Mixers. Catalog A-27 from Philad phia Gear Works.

27A Pipeline Dust Scrubber. Test d from Peerless Mfg. Co.

28L Indicating Pneumatic Controller. Sp cification catalog 510 from United Sta Gauge.

29A Petrochemical Plant Design and Co struction. Blaw-Knox.

30A Bulletins on Equipment Fabricati Downingtown Iron Works.

32A New Design Tower Packing. D from Fluor Products Co. on Poly-G tower packing.

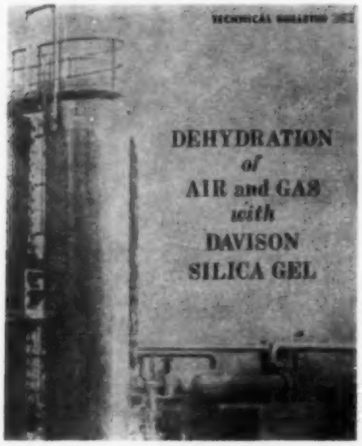
34A Data on Metal Pall Rings. Specific tions and characteristics from U. S. Sto ware.

76A Digital Control Computer. Data fr Thompson-Ramo-Wooldridge Products C on its Model RW-300.

77A New Agitation Drive. Bulletin 9 from Pfaudler Co.

79A Process Equipment Fabrication. D from Sprout-Waldron.

80L Heat Exchangers. Design and fab cation by Aerofin Corp.



Circle No. 410 on post card

TECHNICAL BULLETIN ON AIR AND GAS DEHYDRATION.

The latest information in text and graph form on air and gas dehydration with silica gel. Complete treatment is given to natural gas dehydration; recovery of hydrocarbons from natural gas; compressed air dehydration; atmospheric dehumidification; dehydration of industrial gases. Also featured are the fundamental characteristics of silica gel, special types, and other applications. For a copy of this useful manual from Davison Chemical, circle Number 410 on Data Post Card.

DEVELOPMENTS OF THE MONTH

Circle No. 411 on post card

GLASS-LINED ROTARY DRYER-BLENDER.

Glascote Products, Inc., subsidiary of A. O. Smith Corp., offer a new glass-lined conical rotary dryer-blender suitable for a broad range of corrosive and heat-sensitive materials. The units come in standard sizes from 5 to 35 cu. ft. capacity, with larger capacities up to 255 cu. ft. available on special order. Operating temperatures range up to 500°F for the liner, and 650°F for the jacket. The full tank will operate under pressures from full vacuum up to 25 lb./sq. in. Drive for each unit is a variable-speed electric motor, totally enclosed and explosion proof. For further technical and application data, circle Number 411 on Data Post Card.

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81A Porous Metal Filter Media. Two booklets from Purolator Products, Inc.

82A Fluidizing Conveyors. Technical information from Fuller Co. on Airslide conveyors.

87A Acid Proof Valves. Descriptions and specifications from Lapp Insulator Co.

89A Data on Mixing. Bulletin on mulling from Simpson Mix-Muller Div., National Engineering Co.

91A Heat Exchanger Services. Design, repair, fabrication by Texas Metal Fabricating Co.

92L Filter Press Catalog. Reference manual from D. R. Sperry.

93A Pilot Plant Services. Catalog 381 from Blaw-Knox.

94L Air Classifier Systems. Bulletin AH-467-40 from Hardinge Co.

95A Ion Exchange Equipment. Technical data from Industrial Filter & Pump Mfg. Co.

96BL All-Plastic Gate Valve. Catalog FP-1 from Vanton Pump and Equipment.

96BR Proportioning Temperature Control. Data Sheet 9 from Assembly Products.

97A Mechanical - Type Variable Speed Drive. Reduction ratios to 10,000:1. Cleveland Worm & Gear.

98A Tubing for Atomic Power. Data Memorandum 20 from Superior Tube.

99R High Pressure Reaction Vessels. Catalog 407-S from American Instrument Co.

100L Catalog on Vibrating Screens. Syntron Co.

101A Filters for Atomic Wastes. Design and fabrication by Eimco Corp.

102L Corrosion - Resistant Process Equipment. Bulletins from American Hard Rubber Co.

105R Phenol-Formaldehyde Plants. Process details from Industrial Process Engineers.

106BL Data on Gear Pumps. Technical bulletin 17-A from Schutte and Koerting.

106BR Brochure on Teflon Packing. Flexrock Co.

107A Chemical Relief Valves. Detailed technical information from Milton Roy Co.

108L Alloy Castings. Design and fabrication services by Duraloy Co.

109A Stainless Steel Plate and Forgings. Weekly stock list from G. O. Carlson.

110L Pulse Code Telemetering Systems. Bulletin CP-3701 from Vapor Recovery Systems Co.

111A Jet Venturi Fume Scrubbers. Complete catalog from Croll-Reynolds.

112A-113A Continuous Centrifuges. Sharples Corp.

114B Filter Paper Catalog. Trial quantities also available from Eaton-Dikeman Co.

115A Filteraids. Consulting engineering services on filtration by Dicalite Dept., Great Lakes Carbon.

116L Air Heaters, Inert Gas Generators. John Zink Co.

116R Magnetic Liquid Level Gauges. Engineering sheet from Jerguson Gage & Valve.

117A Bulk Material Handling Equipment. Catalog 556 on conveyors and elevators from Stephens-Adamson.

118L Corrosion-Resistant Filter Medium. Data from Anthracite Equipment Corp.

118BR Batch Mixers. Processing equipment catalog from Troy Engine & Machine.

119R Ceramic - Insulated Thermocouples. Bulletin EDS-54-V from Thermo Electric Co.

120L Steam Jet Coolers. Bulletin 9143-B from Ingersoll-Rand.

120BR After Cooler Systems. Descriptive bulletin 130 from Niagara Blower.

121A Industrial Furnaces. Data from Petro-Chem Development Co.

> Numbers followed by letters refer to equipment, materials, and services advertised in this issue. Numbers indicate pages, and letters position on the page: L, left; R, right; T, top; B, bottom. A indicates full page; IFC, IBC, and OBC are cover advertisements.

122L Fluid-Jet Pulverizing Systems. Details from Sturtevant Mill Co.

122R Plastic Pipe Brochure. Kraloy Plastic Pipe Co.

123A Oxygen Production Facilities. Data from Air Products, Inc.

124L Wire Cloth Catalog and Price List. Cambridge Wire Cloth Co.

125A Rotary Drum Filters. Bulletin 7200 from Dorr-Oliver.

127A Heavy Duty Compressors. Data from Cooper-Bessemer.

128L Water Treatment Equipment. Bulletin 512 from Elgin Softener Corp.

128R Handbook on pH and Chlorine Control. W. A. Taylor & Co.

129A Case History on Air Preheaters. Article from Air Preheater Corp.

130L Corrosion Detectors. Data sheets from Tinker and Rasor.

130BR Heatless Desiccant Air Dryers. Complete data from Kahn and Co.

131A Chemical Process Pumps. Data from Aldrich Pump Co.

132L New Pilot Plant Dryer. Details from C. G. Sargent's Sons Corp.

133L Rotary Screeners. Technical data and prices from J. M. Lehmann Co.

133R Continuous Automatic Presses. E. D. Jones & Sons.

134TL Nickel Alloy Fabrication. Misco Fabricators.

134BL Visual Control Systems. Booklet BE-10 from Graphic Systems.

134BR Heat Exchangers. Bulletins 120 and 135 from Niagara Blower.

138TL Valve Warmer and Cooler. Form V-2 from Dean Products, Inc.

138BL Dust Level Sampler. Technical data from Joseph B. Ficklen, III.

138TR Peristaltic Action Pump. Catalog from Sigmamotor, Inc.

139R Laboratory Glassware. Catalog 50 from Ace Glass, Inc.

IBC Plant Design and Construction. Ralph M. Parsons Co.

OBC Data on Mixers. Catalogs and data sheets from Mixing Equipment Co.

LAPP ALL-SERVICE ACID PROOF VALVES

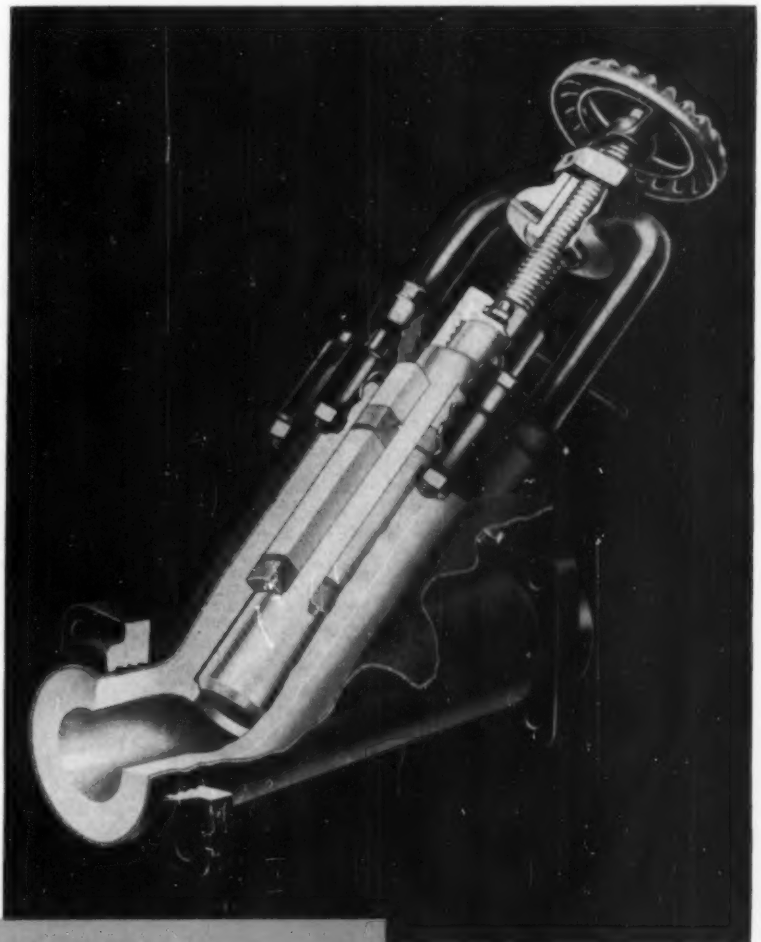
SOLID CHEMICAL PORCELAIN WITH **LAPP TUFCLAD**® ARMOR

Nothing defies corrosion like chemically inert porcelain. As made by Lapp, it is pure, dense, hard, close-grained, homogeneous and non-porous. Therefore there can be *no penetration—no crumbling* from capillary pressures—*no absorption* of liquids to contaminate later processing.

Resistance to corrosion and contamination is but part of the Lapp story; there's a *bonus* in that Lapp Chemical Porcelain costs considerably less initially than most corrosion-resistant alloys and lined equipment. *And* since it almost never needs maintenance or replacement, the economy of your purchase is further increased.

Security (protection of plant and personnel) is assured by the Lapp TUFCLAD armor. It consists of multiple layers of fiberglass impregnated and bonded to the porcelain with an Epoxy resin. Fiberglass has high strength and chemical resistance providing protection against impact damage and external thermal shock. TUFCLAD armor holds line pressures even should porcelain become cracked or broken.

WRITE *for description and specifications for the entire line of Lapp Acid Proof Valves. Lapp Insulator Co., Inc., Process Equipment Div., 2301 Chestnut Street, LeRoy, N. Y.*



Lapp
CHEMICAL PORCELAIN

Y-Valves as shown, and Angle Valves are available in Lapp TUFCLAD Chemical Porcelain in ½" to 6" sizes. Also safety valves, flush valves, plug cocks, pipe and fittings (to 8" dia.) and special shapes.

CEP's DATA SERVICE

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from page 84

338 Process Vapor Fractometer Brochure. Describes the Model 184, made by Perkin-Elmer Corp., gives operating data and specifications, typical applications.

339 Chemically-Resistant Hose. Bulletin from Resistoflex Corp. describes properties and applications of Teflon hose and hose assemblies.

340 Plastic-Coated Steel Pipe and Tubing. Folder from Republic Steel discusses problems of pipeline corrosion and applications of their X-TRU-COAT pipe and tubing.

341 Double-Range Surface Pyrometer. Pyrometer Instrument Co. offers bulletin on Model DR35 PYRO surface pyrometer, designed for laboratory and plant surface and sub-surface temperature measurements.

342 Tubing for Gas-Cooled Atomic Power Plants. Wolverine Tube Division, Calumet & Hecla, announce availability of integrally-finned tubing in low carbon steel and "Magnox" (magnesium-beryllium alloy).

343 Temperature Controls Catalog. Contains data on over 160 standard types and models. United Electric Controls Co.

344 Slide Rule for Chemical Calculations. Bulletin from Frederick Post Co. describes the Chem-Rule, specially designed for quick solution of chemical engineering problems.

345 New Continuous Filtering Centrifugal. Newly-designed automatic horizontal-shaft type can handle up to 20.5 cu. ft. of material per batch. Baker Perkins, Inc., Chemical Machinery Div.

346 Bulletin on Canned Motor Pumps. Performance curves, dimensions, principles of construction, materials, power requirements. Chempump Corp.

347 Heat Exchanger Bulletin. 12-page bulletin from Air Preheater Corp. describes the new Fin-Pak exchanger.

348 Aeration Blending Systems. Technical bulletin from Fuller Co. gives details of new Airmerge System for exact blending of dry pulverized materials.

349 Bulletin on Immersible Motors. Full specifications on ratings from ¾ to 40 hp polyphase and ¾ to 5 hp single phase.

350 Flowmeter Selection Data. Technical bulletin from Fischer & Porter lists advantages and limitations of basic types in chart form.

351 Stainless Steel Centrifugal Pumps. Data on heavy-duty, corrosion-resistant units offered by Ladish Co., Tri-Clover Div.

352 Plate Heat Exchanger Bulletin. List of applications, complete dimensions, mechanical specifications, features. De Laval Separator Co.

353 Corrosion Survey Equipment. Data on use of Cosasco Access Fittings for corrosion surveys inside pipelines and pressure vessels without shutdown of system. Bulletin from Cosasco Div., Perfect Circle Corp.

354 Pulp and Paper Mill Equipment Catalog. 16-page condensed catalog from Sprout, Waldron & Co. gives applications, technical data on refiners, continuous digesters, feeders, etc.

355 Particle Size Analyzer. Bulletin from Mine Safety Appliances Co. describes new low-cost, general purpose instrument for 0.1 to 40-micron particles.

356 Liquid Oxygen Gate Valve. Technical data from Hamer Valves, Inc. on new design, tested down to minus 310°F.

357 New Design Shipping Container. The Deltainer, is a returnable container that seals perfectly, handles toxic or reactive materials safely and economically. Details from Delta Tank Mfg. Co.

358 Technical Data Card on Forged Steel Flanges. Specifications, dimensions, approximate weights. Babcock & Wilcox Co.

359 Vibrating Screen Bulletin. Data on grizzly bar and concentric action screens, screening feeders, unbalanced pulley and pulsating magnet screens. Syntron Co.

360 Selection Guide for Solenoid Valves. Stock list from Automatic Switch Co. contains prices, valve ratings, flow diagrams, engineering data.

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SERVICES *from page 84*

concluded

403 Solvent Extraction Process Data. Universal Oil Products offers data on the Udex process for solvent extraction of benzene, toluene, and xylenes from refinery streams or coke oven light oil. Yields, process requirements, cost estimates.

404 Titanium Welding Techniques. A comprehensive evaluation of successful welding methods, published by the titanium industry. Titanium Metals Corp. of America.

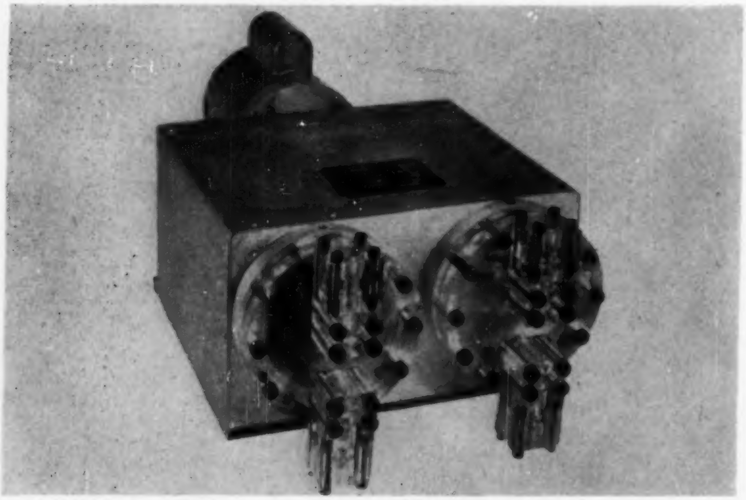
405 Brochure on Applied Catalysis. Catalysts and Chemicals, Inc. offer booklet detailing their know-how and services in the field of applied catalysis.

406 Booklet on Hydrogen Production. New publication of Girdler Construction Div. National Cylinder Gas, describes hydrogen production processes, types of plants, methods of purification, industrial applications.

407 Radioactive Waste Disposal Processes. Brochure on Nuclear Science and Engineering Corp. describes consulting services offered to operators of nuclear power plants.

408 Industrial Waste Disposal Services. Booklet describes systems for water supply, water pollution control, sewage treatment, and air pollution control. Roy F. Weston, Inc.

DEVELOPMENTS OF THE MONTH



CORROSION-RESISTANT DIAPHRAGM PUMP.

Circle Number 412 on post card.

A newly-designed Kemlon pump, made by Keystone Engineering, is a diaphragm-type unit specifically intended for handling corrosive fluids. The new pump is essentially a piston type, differing from standard piston-type pumps only in that it has a barrier diaphragm which separates all of the working parts from the fluid handled. Where ordinary diaphragm pumps depend on the force exerted by the diaphragm itself to do the pumping, the Kemlon pump employs an actuating fluid between the piston and the diaphragm, without mechanical linkage of any kind. All surfaces of the pump which contact corrosive media are of solid fluoro-carbons (Kel-F or Teflon). Other materials available include, for heads and valves: all types of stainless, Hastelloys, rigid PVC, Uscolite, and titanium; for diaphragms; Kel-F elastomer, Hypalon, Hycar, and Neoprene.

The pump is available in both simplex and duplex models. Suction lift is up to 20 ft. with standard design pressures to 50 lb./sq. in.; higher pressures are available for special applications. For complete information, circle Number 412 on Data Post Card.

Controlled dispersion for better blends

If you're coating a fine, dry material; blending liquids into a dry powder . . . or dispersing a small amount of one material into another you need more than a simple stirring, tumbling or agitating action to achieve the desired results.

In the Simpson Mix-Muller a *three-way* kneading, smearing, spatulate action actually coats one material with another—rather than placing them *next* to each other. Agglomerates are broken up, moisture or binder dispersion is thorough. You get an intensive, homogenous mix that *stays* mixed and will not segregate in storage or transit. Want proof? Write for details on a confidential test. See what *mulling* can do and remember . . .

MIXING IS OUR BUSINESS

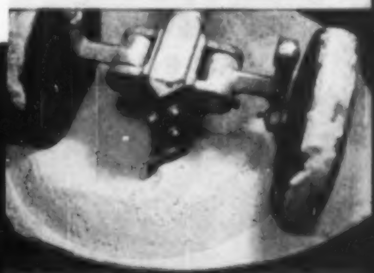
SIMPSON *MIX-MULLER*® DIVISION

National Engineering Company
652 Machinery Hall Building • Chicago, Illinois

3 WAY ACTION
saves time and reprocessing

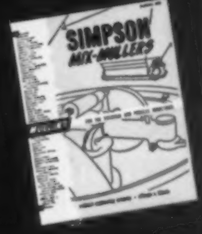
Mix is wetted; dispersion of coating media begins.

As mulling proceeds, mix begins to "lump" up as moisture is dissipated.



Going! As material drys agglomerates break down under intensive mulling action.

◀ **Gone!** Components are thoroughly blended. Mix is uniform, smooth flowing . . . quickly achieved.



WRITE FOR Bulletin on *Mulling for the Chemical and Process Industry.*

CEP's DATA SERVICE

EQUIPMENT *from page 88*

361 Hydraulic Hand Testing Pump. A handy portable unit for all types of high and low-pressure testing. Bulletin from Baker Oil Tools, Inc.

362 Saran-Lined Pipe, Valves, Pumps. 36-page bulletin from Saran Lined Pipe Co. gives complete specifications, fabrication and chemical resistance data.

363 Price Bulletin on Non-Metallic Pipe Fittings. Bulletin from Fibercast Co. covers complete line of Fibercast fittings.

364 Jacketed Valves. Bulletin from Alloy Steel Products Co. gives details of completely jacketed gate, globe, and check valves.

365 All-Teflon End-face Shaft Seal. Crane Packing Co. offers data on new bellows-type end-face shaft seal in which only Teflon is exposed to the liquid.

366 Gravity and Power Conveyors. Bulletins from Standard Conveyor Co. describes complete line of conveyors and pneumatic-tube dispatching systems.

367 Anti-Corrosion Pressure Switches. Suitable for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, amine fuels, fluorine. Bulletin from Barksdale Valves.

368 Liquid Level Sensor. Technical bulletin from Robertshaw-Fulton Controls Co. shows details of the Betatrol, which imploys beta radiation for liquid level control.

369 Pump Selection Data. Two bulletins from Manton-Gaulin Mfg. Co. give specifications of their Twin-Lobe and high-pressure pump lines.

370 Engineering Report on Mixing. Bulletin from Rietz Mfg. Co. outlines mechanical design principles of their equipment for simultaneous size reduction and heat exchange.

371 Rectification Plant Catalog. Superior Air Products Co. catalog describes plants for production of oxygen and/or nitrogen in liquid or gaseous form. Complete technical data.

372 Dust Collector Bulletin. Eight-page booklet on the Dualaire jet-cleaned dust collector is offered by Western Precipitation Corp.

373 Flexible Metal Hose Catalog. 36-page bulletin describes all types of flexible metal hose in steel and corrosion-resistant alloys. Pennsylvania Flexible Metallic Tubing Co.

374 Data on Ultrasonic Homogenizers. Sonic homogenizers, made by Sonic Engineering Corp., use the fluid-dynamic forces of the liquids themselves to produce the sound waves.

375 All-Plastic Molded Valve Operator. Available in PVC, Kralastic, and in Penton and Profax, Hercules Powder's newly-developed polymers. Chemtrol, division of Tapered Air Products.

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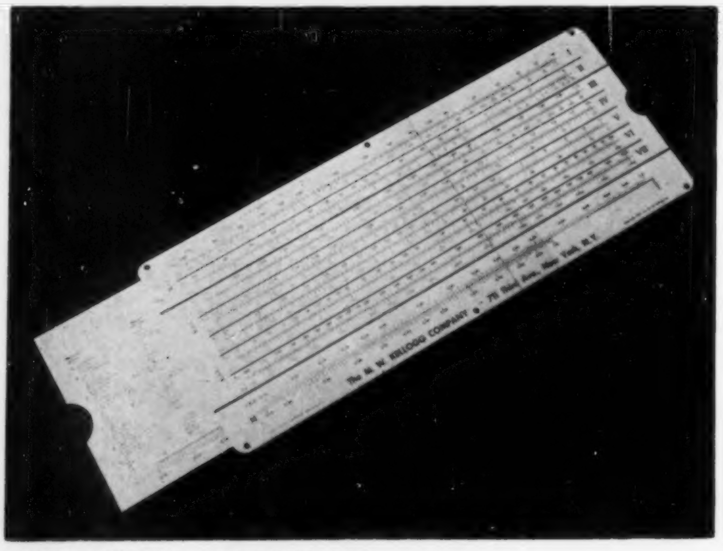
DEVELOPMENTS OF THE MONTH



EQUILIBRIUM FLASH SLIDERULE.

Circle Number 413 on post card.

A new sliderule, developed by M. W. Kellogg, will save time in making equilibrium flash calculations. It is based on a newly-developed formulation which converges toward the final solution more rapidly than the conventional calculation routine. The calculation may be started with any arbitrarily assumed value of the percent vaporization. The essence of the method lies in the fact that the next trial value to be assumed is automatically derived from the discrepancy found as a result of the preceding trial. Full directions accompany the sliderule. For one of these useful instruments, circle Number 413 on the Data Post Card.

MATERIALS *from page 84*

304 Catalog of Chemicals. 162-page catalog lists over 4,000 fine organics, inorganic reagents, indicators, and stains. Matheson Coleman & Bell.

305 Brochure on Pure Titanium. Includes full-page chart comparing corrosion resistance of titanium, zirconium, tantalum, and 316 stainless steel in large number of corrosive media. Mallory-Sharon Metals Corp.

306 Catalog of Organic Intermediates. Revised to include over 100 organic intermediates which can be supplied in commercial quantities. Aceto Chemical Co.

307 Silicone Rubber Compounds. Product and application information from Silicone Products Dept., General Electric, on three new general purpose silicone rubber compounds.

308 Booklet on Organic Chlorine Compounds. Union Carbide Chemicals Co. offers 45-page booklet which gives physical and physiological properties, use information, specifications, shipping and handling information.

309 Normal Butylene Isomers. Texas Butadiene & Chemical announces commercial availability of high-purity butene-2 and butene-1 concentrate. Technical data.

310 Brochure on Epoxy Resins. Brochure from Marblette Corp. includes chart of recommended formulations for many characteristic applications.

311 Corrosion Data on Stainless Steels. New data chart from Peter A. Frasse & Co. shows relative corrosion resistance of 34 standard grades of stainless steels.

312 Low Durometer Silicone Rubber Compound. Samples of and data on new compound M-717 offered by Connecticut Hard Rubber Co.

314 Amine Catalysts for Urethane Foam. New series of amine catalysts, made by American Alcolac Corp. said to produce urethane foams with good physical properties, low compression set. Technical data.

315 New Nickel-Alloy Plate Steel. New "Nine Nickel," product of Lukens Steel Co., has high impact resistance and strength at temperatures down to minus 320°F.

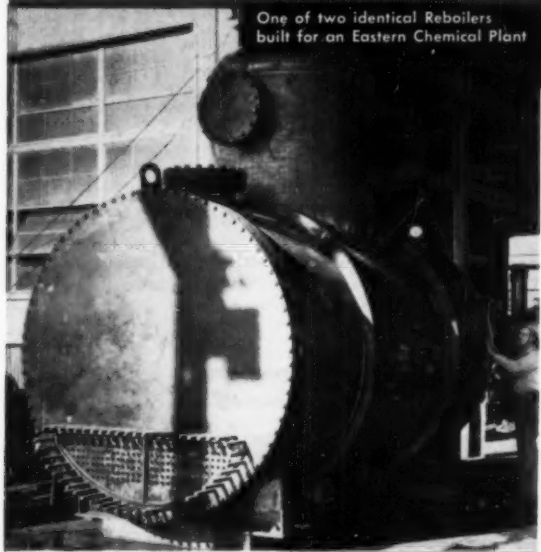
316 Booklet on Organic Chemicals. Technical data, shipping information on glycols-ethylene, diethylene, triethylene and polyethylene-glycol ethers, ethanolamines and surfactants. Olin Mathieson Chemical Corp. Organic Chemicals Div.

317 Porous Materials for Industrial Filtration. New materials developed by Corning Glass Works, have particle retention ranging from 2 to 120 microns, high mechanical strength, chemical and thermal shock resistance. Technical data.

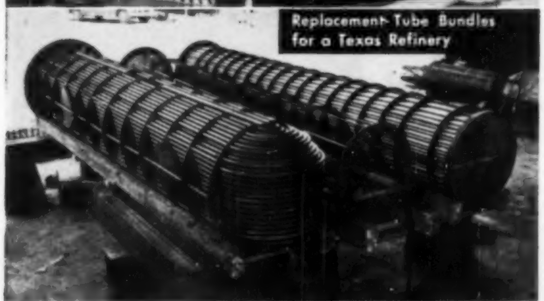
318 New Diepoxides. Bulletins from Becco Chemical Div., Food Machinery and Chemical Corp. describe dicyclopentadiene dioxide and limonene dioxide. Samples also available.

continued on page 92

A Superior Service for
HEAT EXCHANGERS



One of two identical Reboilers built for an Eastern Chemical Plant



Replacement Tube Bundles for a Texas Refinery

Texas Metal Exchangers for a Canadian Chemical Plant

for the
PETROLEUM and CHEMICAL Industries

Performance engineered to fit YOUR heat transfer needs.

DESIGN
REPAIR
FABRICATION

Your inquiries are cordially invited.

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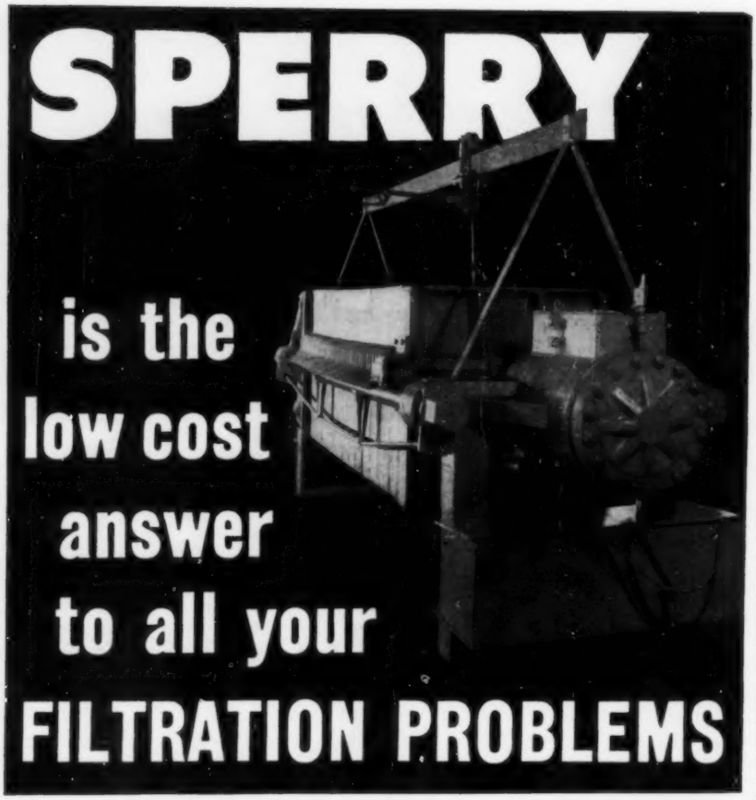
Qualified for Construction in Ferrous and Non-Ferrous Materials

TEXAS METAL FABRICATING COMPANY

MAIL ADDRESS: P. O. BOX [illegible], HOUSTON 7, TEXAS

Our [illegible] Anniversary of Service to the Petro-Chemical Industry



Consider all the money-saving aspects of a Sperry Filter Press. These include low initial cost . . . nominal installation . . . minimum maintenance . . . low depreciation . . . and an economy of operation that extends through many years of trouble-free performance.

However complex your filtration problems may be, these economies are basic to the solution.

You can avail your plant to the economies of a Sperry Filter Press,custom-engineered to meet your particular requirements for flow rate, cake build-up, washing, extraction, thickening, etc. Variations are provided, offering center, side or corner feed; open or closed delivery; simple or thorough washing; high or low temperature control. Plates may be had in aluminum, wood, iron, bronze, stainless steel, lead, rubber, nickel or any other special materials to meet your requirements. Any filter media can be used . . . cloth, synthetics, wire screen . . . paper. Labor-saving plate shifting devices and semi-automatic closing attachments are adaptable for any model . . . to increase production, minimize operation hazards and reduce wear and tear.

FOR A LOW-COST ANSWER TO YOUR FILTRATION PROBLEMS, SEE THIS SPERRY CATALOG . . .
an up-to-date fully illustrated reference manual of erection, operating, design and construction data and specifications. Mail coupon for your free copy today.

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CEP-6

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CEP's DATA SERVICE

MATERIALS *from page 90*

319 Silicone Carbide Bulletin. Self-bonding process provides high strength, other outstanding properties up to 4,000°F. Carborundum Co.

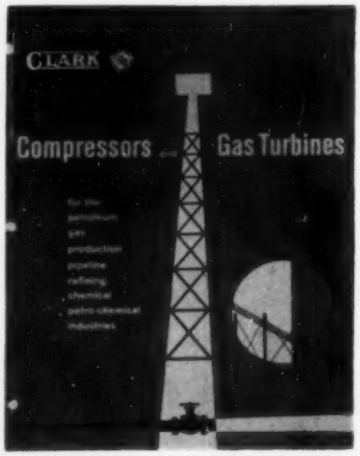
320 New Anti-Corrosion Protective Coating. Permaspray, new furan resin base compound described in bulletin from Permaspray Manufacturing Corp.

321 Booklet on Aliphatic Chemicals. Gives chemical and physical properties of "Duomeens" and their salts, general reactions and applications. Armour and Co., Chemical Div.

322 Plastics Catalog and Price List. Cadillac Plastic & Chemical Co. offers 64-page catalog of plastic sheets, rods, tubes, films, and lay-flat tubings. Also cements, pigments and miscellaneous supplies.

323 Technical Data File on Butadiene-Styrene Rubbers. Specifications, physical and chemical properties, typical production values, standard test recipes. Texas-U. S. Chemical Co.

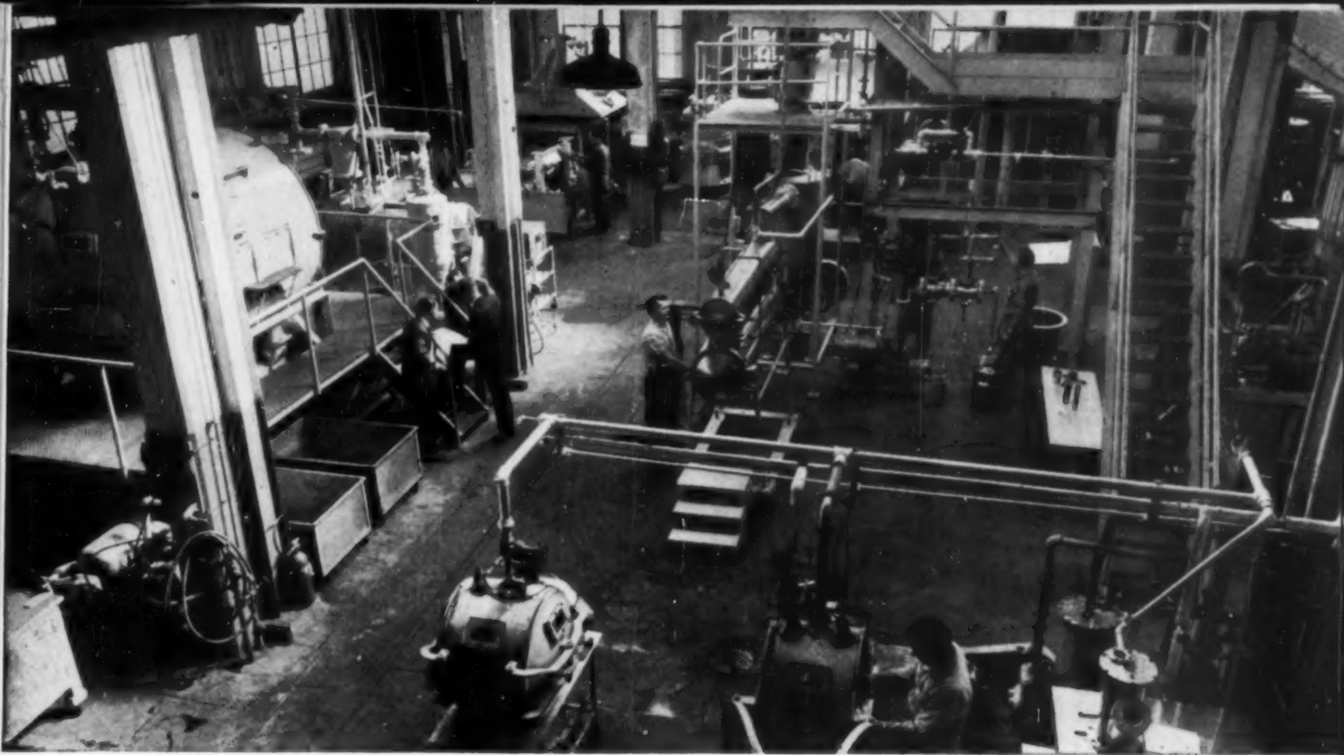
Developments of the month



COMPRESSOR AND GAS TURBINE CATALOG.

Circle Number 414 on post card.

A 40-page catalog from Clark Bros. Co. gives latest engineering and performance data on their complete line of compressors and gas turbines for the petroleum, chemical, and petroleum industries. Under reciprocating compressors, detailed specifications and diagrams are given on gas-engine-driven, steam-engine-driven, and electric motor-driven types. Included are unit characteristics and application suggestions. The section on centrifugal compressors offers data on vertically and horizontally-split multistage units. Axial-flow compressors and radial inflow expanders are also featured. Full specifications and engineering data are given on standard model gas turbines in the horsepower range of 1,150 to 9,300. For a copy of this comprehensive catalog, circle Number 414 on Data Post Card.

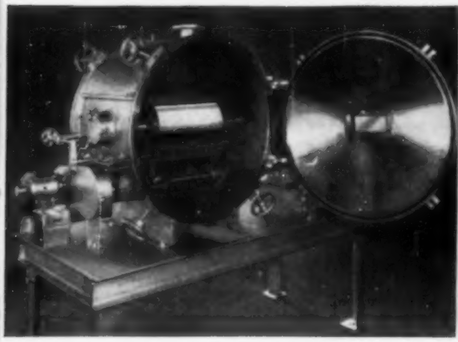


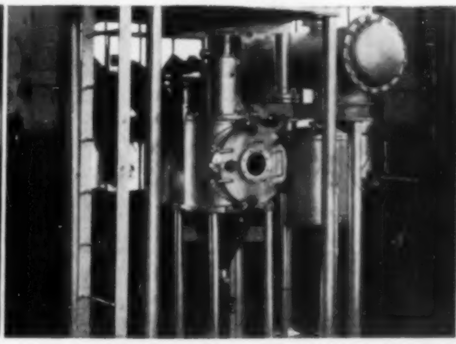
Start your pilot-plant projects in Buflovak's big processing lab

Whether you test a few beakers of precious material or run tank car quantities on a round the clock production scale, Buflovak's customer service laboratory is equipped for the job. An ultra-modern line of small scale and semi-plant size units makes this lab the outstanding center for investigating drying, evaporating, extraction, impregnation, crystallization and other related processes.

Constant research keeps Buflovak equipment—ranging from evaporators and dryers to kettles, autoclaves and flakers—the most advanced in the field, the most dependable in operation.

Top equipment and a distinguished engineering staff have solved over 7,000 processing problems. See how this know-how can work for you in your own product-process research. Write for Catalog 381. Additional details also available in the Chemical Engineering Catalog, pages 429 to 452.





Modernize your lab. Make your lab as up-to-date as Buflovak's research center. Choose from a complete line of dryers, evaporators and processing kettles designed for a small scale operation.

BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1567 Fillmore Avenue, Buffalo 11, N.Y.

change from...

40 MESH

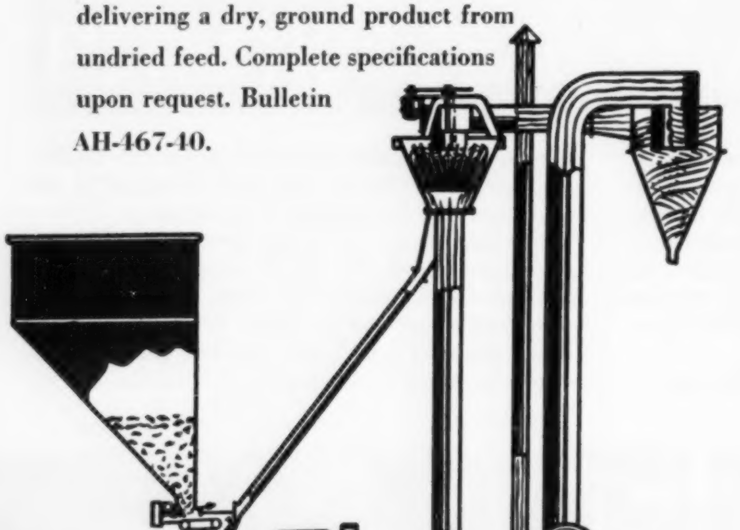
to

400 MESH

. . . in a few minutes, without interrupting operations. Yet any desired mesh may be maintained continuously. Ease of adjustment and close product control are possible with the . . .

"Gyrotor" Air Classifier

The Hardinge Gyrotor Classifier system, combined with a Hardinge grinding mill is an integrated grinding, classifying and product conveying system. Also available with an air-heating furnace for delivering a dry, ground product from undried feed. Complete specifications upon request. Bulletin AH-467-40.



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CEP's DATA SERVICE

EQUIPMENT *from page 90*

376 Rotary Positive Blowers. Six-page bulletin from Miehle-Dexter gives operating data, performance curves, specifications on full line of 24 models.

377 Bulletin on Slow Speed Mixers. Details of turbine mixers, mixer drive heads, slow speed mixers. International Engineering, Inc.

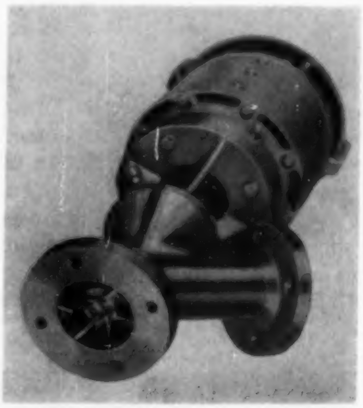
378 Pilot-Operated Relief Valves. Specially-designed for cone-roof and other low pressure tanks. Bulletin from Johnston & Jennings Co.

379 Automatic Injector Unit. Pump-meter combination permits homogeneous on-stream blending. Technical data from Granberg Corp.

380 Ceramic Vacuum Pumps and Compressors. Brochure from General Ceramics Corp. gives details, drawings of armored chemical ceramic vacuum pumps and compressors.

381 Backward-Blade Centrifugal Fans. Bulletin includes engineering data, specifications, performance tables, selection and arrangement information on 19 basic size centrifugal fans. General Blower Co.

Developments of the month

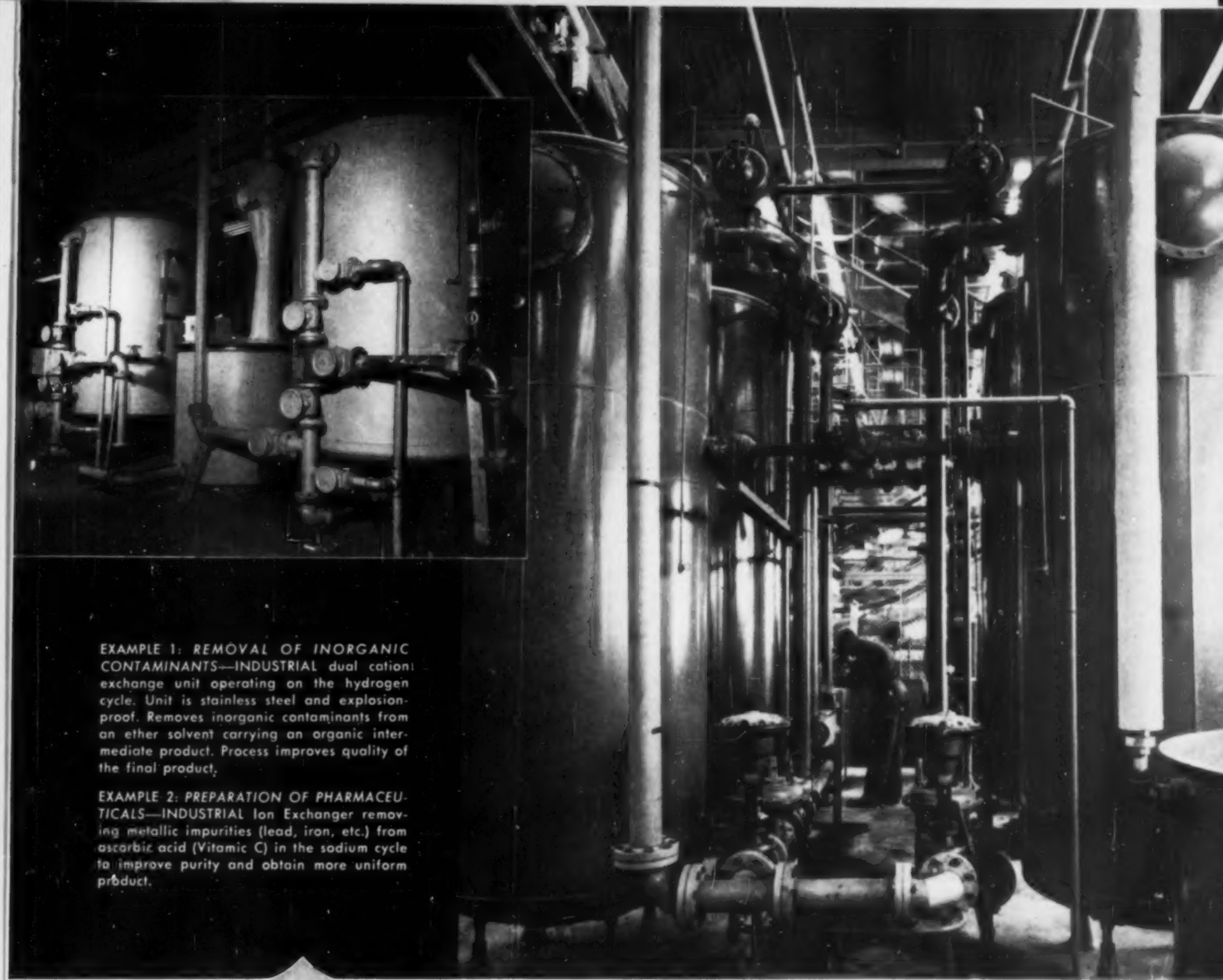


PIPE LINE HOMOGENIZER MIXER.

Circle Number 415 on post card.

The continuous-flow "Pipe-Line" Homomixer, manufactured by Gifford-Wood Co., Eppenbach Div., is powered by a motor which is coupled to a shaft terminating in a turbine. This rotates in an enclosed housing or stator to form the homogenizing head. Unrefined material is drawn from the pipe into the homogenizing zone by the pumping action of the turbine. Here it is forced to pass through restricted openings in the mixing head where it is sheared and broken down to primary particle size. It is then discharged into the outlet pipe.

The unit can be installed on existing pipe lines or made up with standard fittings for use where a pipe line does not currently exist. It has the added feature that, with many mixtures, it can also be used as a transfer agent. All units may be mounted either horizontally or vertically. For additional information, circle Number 415 on the Data Post Card.



EXAMPLE 1: *REMOVAL OF INORGANIC CONTAMINANTS*—INDUSTRIAL dual cation exchange unit operating on the hydrogen cycle. Unit is stainless steel and explosion-proof. Removes inorganic contaminants from an ether solvent carrying an organic intermediate product. Process improves quality of the final product.

EXAMPLE 2: *PREPARATION OF PHARMACEUTICALS*—INDUSTRIAL Ion Exchanger removing metallic impurities (lead, iron, etc.) from ascorbic acid (Vitamic C) in the sodium cycle to improve purity and obtain more uniform product.

INDUSTRIAL ION EXCHANGERS

meet highest purity standards for continuous processes

Every day INDUSTRIAL Ion Exchangers are *replacing* expensive, complicated processing equipment in the purification of literally hundreds of chemical products. Why? Because INDUSTRIAL has successfully adapted the newest developments in ion exchange research to simple techniques. This new equipment provides advantages like these: NO HOLD-UP TIME . . . LOWER CAPITAL INVESTMENT . . . LOWER OPERATING COSTS . . . PLUS—PURITY STANDARDS TO MEET VIRTUALLY ALL REQUIREMENTS!

The operating simplicity of these new techniques permits immediate integration of an INDUSTRIAL Ion Exchanger in almost any continuous chemical process. The views on this page show some current specialized applications.

Investigate how INDUSTRIAL Ion Exchange equipment can solve your purifying problems at lower costs. Call or write today for details covering an analytical economics study.

INDUSTRIAL

C-258

INDUSTRIAL FILTER & PUMP MFG. CO.
5910 Ogden Avenue, Chicago 50, Illinois

PRESSURE FILTERS ◆ ION & HEAT EXCHANGERS ◆ WASTE-TREATING EQUIPMENT

. . . plan for your

September sojourn in Salt Lake City

FRANK M. PARKER
Salt Lake Refining Co.

Mormon Temple and Tabernacle, across from headquarters hotel.

The reality of the Salt Lake City area will come as a stunning surprise to many who, brought up on the almost legendary history of the Mormon migration, tend to think of Salt Lake only in terms of the Mormon Temple, the Tabernacle, and Great Salt Lake. Recreational and tourist attractions amid unparalleled scenic grandeur, the stimulating atmosphere of one of the country's most rapidly-growing industrial centers—all this, plus a varied and penetrating program of technical papers and symposia, awaits the chemical engineer who plans to "migrate" to Salt Lake City for the September National Meeting of A.I.Ch.E. (Sept. 22-27).

The sunny, cool, September weather, the setting, and the occasion combine to suggest making your vacation coincide with attendance at the meeting. Now is the time, particularly for those unfortunates who have never explored the West, to make the big jump (with families, if possible).

The beauties of Salt Lake City itself are of course world-famous—the immense Mormon Temple with its six-foot thick walls of native granite, the Tabernacle whose spreading roof was originally of wood held together with wooden pegs and cowhide thongs, the 23 parks which cover more than one-fifth of the city's area, the wide tree-lined streets. Less known, but equally worth exploring, are the natural wonders to be found within a radius of two or three hour's driving. Some of the most beautiful, for example, the six canyons opening into Salt Lake Valley, are only a few minutes away, hardly beyond the city limits.

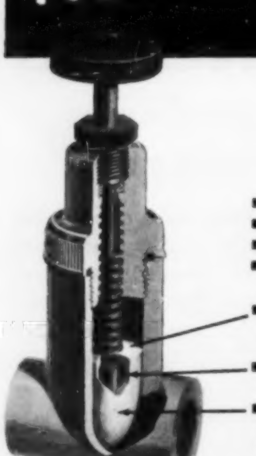
For those farsighted enough to arrange vacation time in Salt Lake, exciting excursions beckon from all directions. Timpanogos Cave, Granddaddy Lakes (excellent trout fishing), and the Bonneville Salt Flats are within easy reach. A little further

continued on page 99

NEW! ALL-PLASTIC GATE VALVE

VANTON
FLEX-PLUG*
VALVE
½"-2" sizes

- No-pressure-drop construction of gate valve
- Throttling flow-control feature of globe valve
- PVC or styrene-copolymer construction
- Handles wide range of corrosives and slurries



- Back-seating feature of cap: when valve completely open, relieves pressure on packing.
- Free-to-swivel plug: provides even wear of cap, perfect closure.
- Flexible synthetic cap: easily replaced without removal of valve from line; minimal maintenance. Handles abrasive slurries without wear.
- All-plastic design — PVC or styrene-copolymer. Replaceable caps available in Neoprene, Buna-N, and Hypalon (Kel-F elastomer on special order).
- Suitable for vacuum — resilient cap makes excellent seal.
- Adaptable to all existing plastic pipe and fittings; especially suited to Vanton P, S, and N lines of plastic pipe and fittings.
- Rated for 150-lb. service—PVC line up to 140°F., styrene-copolymer line to 170°F.

*Pat. Pending

Catalog FP-1 gives full details. Write for it today!

VANTON PUMP and Equipment Corp. • Hillside, N. J.
DIVISION OF COOPER ALLOY CORP.

api Proportioning Temperature Control

SIMPLYTROL

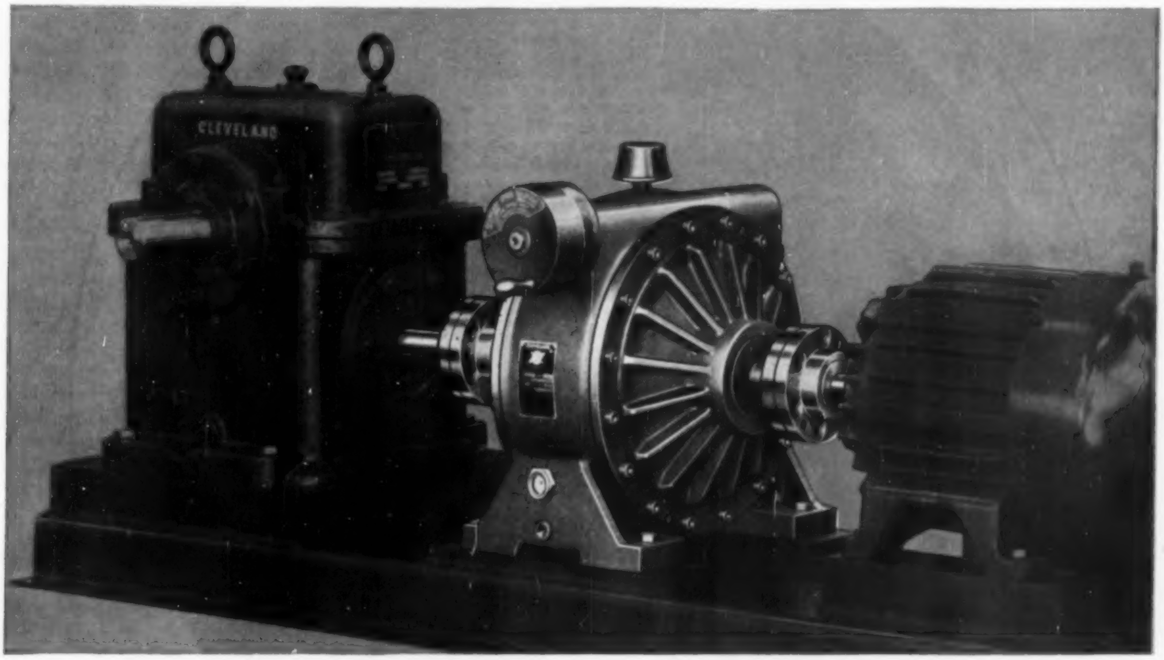
Users report this time proportioner holds temperature to ±1°. Its new anticipating circuit builds up open circuit voltage across the meter-relay contacts, achieving the most in reliability and giving straight line control in even the toughest applications.

This PR Simplytrol indicates continuously; reads directly; uses no amplifier or electron tubes; costs less than other temperature controls. 30 ranges from −400°F. to +3000°F. Approximately 6½" x 6½" x 10". Shallower models available in quantity.

Ask for Data Sheet 9

Assembly Products Inc.
Chesterland 75, Ohio
Booth 307, Automation Exposition
June 9-13, New York Coliseum

Industry's most positive mechanical-type variable speed drive



CLEVELAND SPEED VARIATOR

Supplemented with speed reducers can provide reduction ratios to 10,000:1

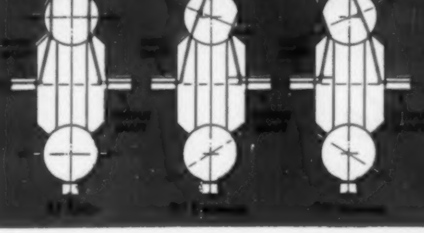
IN installing a Cleveland Speed Variator, the higher the input speed (normally 1750 rpm), the smaller the unit needed. Where power must be delivered at speeds below the Variator's normal output shaft speeds, further reductions are available between Variator and driven equipment.

As illustrated above, the Variator may be assembled with a standard worm gear speed reducer or with integral double reduction helical gear trains. Write for Bulletin K-200. The Cleveland Worm & Gear Company, Speed Variator Division, 3257 East 80th Street, Cleveland 4, Ohio.

Note these major advantages of the Cleveland Speed Variator

1. An extremely compact unit, with input and output shafts in line and rotating in the same direction.
2. Operable at any input speed up to 1800 rpm—either clockwise or counterclockwise rotation.
3. Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant torque over a 6:1 range.
4. Infinitely variable output speeds over the entire range of adjustment.
5. No slippage—positive, automatic torque adjustment in direct proportion to the loads encountered.

HOW THE CLEVELAND SPEED VARIATOR WORKS

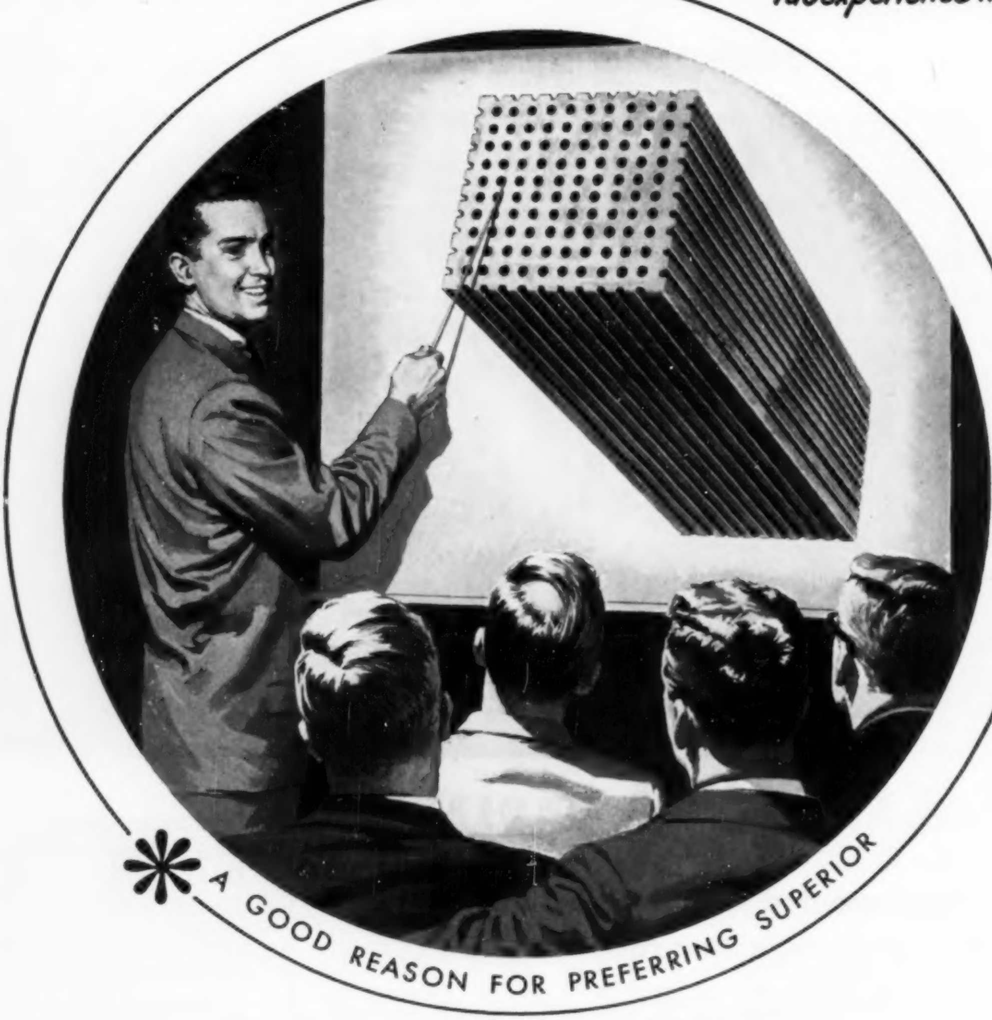


Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (diagram, right, shows cutaway Variator with hand regulating wheel).

"It's the Drive That's on the Ball."

Tubexperience in action



Fission under a blanket

Part of a nuclear core — a blanket of uranium oxide pellets held in a bundle of Zircaloy-2 tubes made by Superior

*Applications like this call for tubing that is special in every sense of the word. Zircaloy-2 tubing requires the highest skills in tubing manufacture. It is produced to extremely close tolerances, including those for concentricity, and with virtually no imperfections. High surface uniformity is needed and also ultraprecise dimensions. Any contamination by nitrogen, oxygen or hydrogen must be very low. It must also offer an excellent degree of weldability.

Superior regularly produces small diameter tubing to meet these and other exacting specifications for the nuclear energy industry; our stainless steel tubing, for example, is widely used for fuel element cladding, heat exchangers, other accessory equipment, instruments, and mechanical processing applications. And our extensive testing facilities enable us to thoroughly check this tubing out before shipping it. Eddy current, ultrasonic, dye penetrant, and many other tests and inspection methods are available.

For more data on the wealth of experience, facilities and trained personnel available to you for producing highly specialized tubing, write for a free copy of our Data Memorandum #20 on "Tubing for Atomic Power." Superior Tube Company, 2011 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to 5/8 in. OD—certain analyses in light walls up to 2½ in. OD

Salt Lake

from page 96

afield are Yellowstone and Grand Teton National Parks and Sun Valley.

Sports, too, are part of Salt Lake living; several fine golf courses and fresh water swimming are readily available, not to mention the thrill of a dip into Great Salt Lake itself. For gourmets (and others who prefer indoor sports), the city offers a splendid array of restaurants, theatres, and night clubs.

Industrial Hub

Salt Lake City is said to be the greatest non-ferrous smelting center in the world. Since the Second World War, Utah has become also one of the great steel producing areas of the nation; the Geneva Steel Plant at Geneva, Utah, is said to be the world's largest and finest integrated steel works. The plant uses native iron ore, coal, and limestone.

Around this nucleus of metallurgical activity has grown up a significant complex of chemical industry. Sulfuric, phosphoric, hydrochloric, and nitric acid are made in growing quantities, while by-product coking materials from the steel operations at Geneva and Ironton can furnish the raw materials for further chemical development.

Oil refining is booming near Salt Lake City, operating mostly on oil piped in from Colorado. In recent years, however, several oil fields within the state have gone into production, and several large natural gas fields are presently being exploited.

Outstanding Technical Program

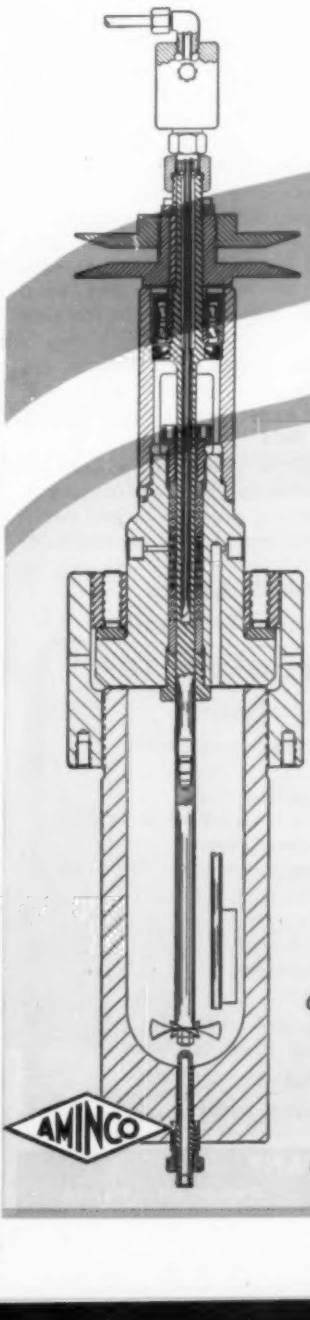
From Air Pollution to What's New in Liquid Metals Technology, the technical program scheduled for Salt Lake City will synthesize the latest developments in chemical engineering theory and practice, and will stimulate new insights and points of view. Of special interest will be the sessions of Ethylene, Petroleum Refining, and Safety in Air and Ammonia Plants.

Big Cottonwood Canyon
near Salt Lake City

TOP-STIRRED---HIGH PRESSURE

REACTION VESSELS

With specially-designed Stuffing Box that prevents leakage of lubricant into vessel or reactance out of vessel.



Aminco's specially-designed stuffing box utilizes a spacer-spring in place of the conventional lantern gland. This spring pre-loads the bottom packings, thus effectively preventing leakage.

Standard Models:

1 liter (4⅜-in. o.d.—6250 psi maximum pressure).

½ gal. and 1 gal. (6⅞-in. o.d.—9100 and 5600 psi maximum pressure respectively).

Units up to 20 gal. Available on special order.

Normally supplied with propeller type agitator, unit may be supplied with gas-liquid dispersion type agitator on special order.

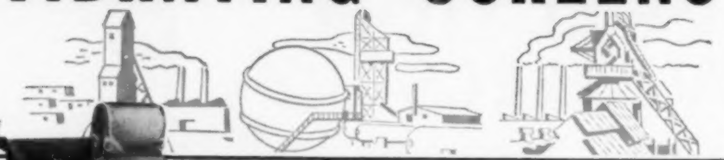
Complete information in **CATALOG 407-S**
Available upon request

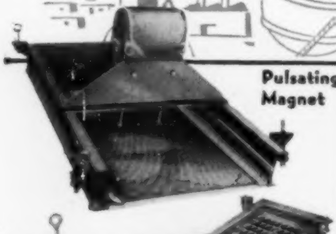
AMINCO

AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Md.

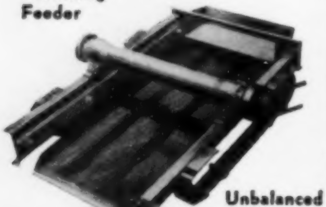
SYNTRON VIBRATING SCREENS



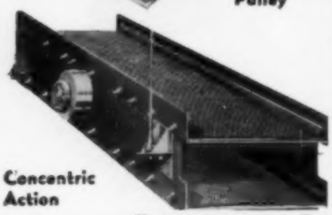


Pulsating Magnet

Screening Feeder



Unbalanced Pulley



Concentric Action

do an efficient, dependable job of sizing, separating, dedusting and dewatering - - -

SYNTRON offers a complete line of Vibrating Screens in a range of sizes and styles for practically every screening problem — fine, medium and coarse — dry or wet — from light capacities to heavy tonnages.

SYNTRON Vibrating Screens are designed and built for long, dependable service and combine high capacity output with quality control of materials. They are compact and functional in design, allowing more flexibility of installation and keep moving parts to a minimum for simple, low cost maintenance.

SYNTRON Vibrating Screens are backed by more than a third of a century of experience in the materials handling field.

SYNTRON'S years of experience are available to you. Send details of your screening problem to our application engineers for recommendations.

CH 358

Equipment of Proven Dependable Quality

Products of Proven Dependable Quality

Other SYNTRON Equipment

designed to increase production, cut production costs, improve products

- Vibrators (bins, hoppers, chutes)
- Vibratory Feeders
- Vibratory Screens
- Shaker Conveyors
- Vibratory Elevator Feeders
- Weigh Feeders
- Packers and Jolters
- Hopper Feeders
- Lapping Machines
- Rectifiers (Silicon and Selenium)
- a-c to d-c Selenium Rectifier Units
- Electric Heating Panels
- Electric Heating Elements
- Sinuated Wires
- Shaft Seals
- Electric Hammers
- Concrete Vibrators
- Paper Joggers

Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

For more information write for complete catalog . . Free

SYNTRON COMPANY

116 Lexington Avenue Homer City, Penna.

industrial news

An electronic computer data-processing system designed to sustain peak operational efficiency in a catalytic reformer producing some 10,000 barrels of high-octane gasoline will be installed at Continental Oil's Ponca City, Okla., refinery in June. Installer will be the Systems Division of Beckman Instruments, Inc. The new system will automatically compute production yields and other operating statistics essential to optimum process control, provide a continuous record of plant performance, and alert operators if any one of 100 key process variables drifts outside established limits. The system will be fully transistorized for maximum reliability. The use of advanced solid state components in place of vacuum tubes will permit the unit to operate continuously for extended periods of time. #

A one-year process improvement project involving the oxidation of crotonaldehyde to crotonic acid, has been successfully concluded by Eastman Chemical Products, a subsidiary of Eastman Kodak. Principal among the problems solved, was the control of the reaction so that oxidation takes place only at the aldehyde grouping, does not produce unwanted by-products, such as acetaldehyde, from oxidation occurring at the double bond. Success of the process improvement project will enable Eastman to produce crotonic acid commercially at an introductory price of 36 cents a pound. #

A contract covering the performance of specialized radio-chemical assays of such fission products as cesium, strontium, cobalt, iron, barium, manganese, iodine, and others has been awarded to the West Coast division of Tracerlab, Inc. by Westinghouse Electric's Bettis Atomic Power Division. #

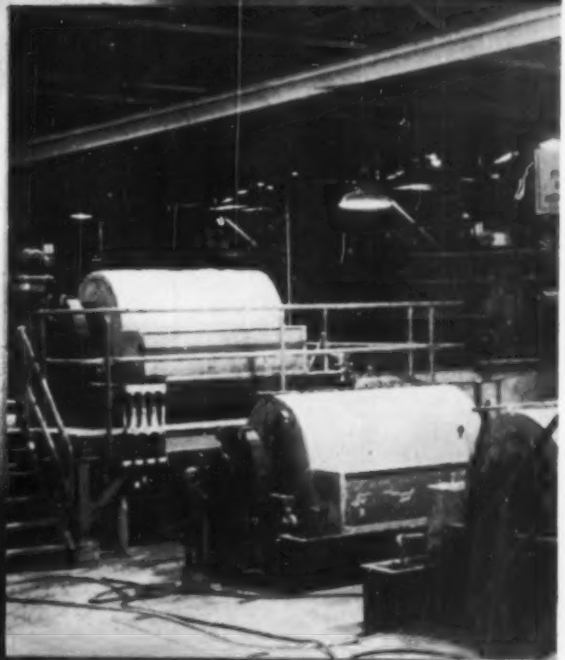
Extruders, Inc., suppliers of polyethylene film to the West Coast, has been bought by Dow Chemical, will operate as a Dow subsidiary. #

Super high-purity aluminum (99.99) is now being produced commercially by Reynolds Metals Co. Standard sale size is seven pound ingots, the material is used mainly in catalysts for high octane petroleum refining and for special wrought products requiring a special finish. #

HANDLING ATOMIC WASTES

Handling wastes from Atom Power Plants is just another task at Eimco for waste treatment facilities designed and manufactured for all industries.

Eimco Research and Development Division has anticipated this need and when the need developed customers were given the benefit of research already in an advanced stage.



Eimco filters are successfully operating on atomic wastes — another illustration of Eimco ability to anticipate the needs of industry — its willingness to proceed with the investment in necessary research — to offer you the most advanced technology in equipment that will do your job most efficiently, most trouble free, and in the long run most economically.

THE EIMCO CORPORATION

SALT LAKE CITY, UTAH

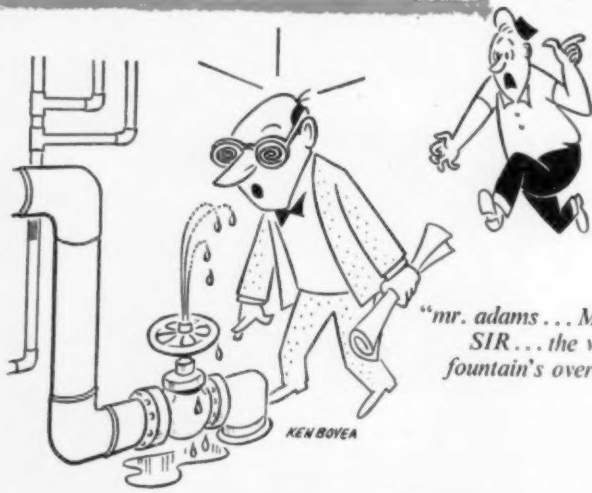
Research and Development Division, Palatine, Illinois • Process Engineers Inc. Division, San Mateo, California

Export Offices: Eimco Building, 51-52 South Street, New York 5, N. Y.

BRANCHES AND DEALERS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

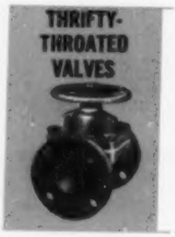
B - 317

Life in these excited states...



"mr. adams . . . Mr. Adams . . . SIR . . . the water fountain's over here!"

Highest pumping efficiency, with faultless corrosion resistance. Hard rubber casing and impeller; Hastelloy *C* shaft. 80 gpm. *Bul. CE-55.*



Liquids never touch metal in Ace diaphragm valves! Rubber or plastic-lined cast iron, or solid plastic bodies. Sizes ½ to 6". Ask for facts.

High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

Why men of vision choose ACE equipment

Men with a weakness for profits somehow manage to keep equipment "on stream" full time with no corrosion shutdowns. You'll find they reach for Ace corrosion-engineered equipment time and again. Now nine kinds of Ace pipe . . . plus pumps, valves, tanks, and special equipment to solve most any corrosion or contamination problem.

All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Free Bul. CE-56.*

See our pages in cec Catalog!

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
Ace Road • Butler, New Jersey

industrial news

New Data on Molecular Sieves.

CEP in May (page 171) reported on Union Carbide's use of molecular sieves as carriers for volatile catalysts such as di-tertiary butyl peroxide. New experimental data has now been released on the efficiency of this method in the curing of synthetic rubbers and plastics.

Use of very active or volatile curing agents, some of which were formerly almost impossible to handle, is now claimed possible because they can be locked in molecular sieves and held inactive at ambient or processing temperatures. At curing temperatures, the active compound is then released into the system. Further advantage is increased storage stability which allows use of one rather than two-package marketing systems.

Comparative curing tests on a silicone rubber were carried out with liquid di-tertiary butyl peroxide and CW-2015 (the same compound adsorbed on molecular sieves). In two days of preliminary bin aging, the liquid agent was completely lost and no curing resulted. With CW-2015, a complete cure was obtained after 14 days bin aging—tensile strength: 1,080 lb./sq. in., percent elongation: 320. This compares with a tensile strength of 940 and an elongation of 310 obtained with the liquid agent used immediately without bin aging.

Addition of a curing peroxide such as benzoyl peroxide to polyethylene glycol dimethacrylate caused this material to gel in less than five days at 122°F, and in less than 20 minutes at 210°F. When CW-2015 was used as the catalyst, there was little change in the material after 15 days at 122°F, or after 8 hours at 210°F. Both catalysts resulted in formation of a hard resin after 5 minutes at 350°F.

Five types of chemically-loaded molecular sieves are now offered by Union Carbide, more varieties are under development. Development price is $3.00/lb.

New nitrogen facilities have been put into operation at two Linde Co. (Carbide) plants. The installation at the company's Houston plant has a capacity of over 1 million cu. ft., while the Tulsa unit has slightly less than 1 million cu. ft. capacity. #

Pending stockholders approval, National Cylinder Gas Co. will be renamed, "Chemetron Corp." #

ADVERTISEMENT—*This entire page is a paid advertisement*

Prepared by U. S. Industrial Chemicals Co.

U.S.I. CHEMICAL NEWS

June ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

New Electron Beam Melting And Casting Process Gives High Purity Special Metals

A new process employs electron beam bombardment in a high vacuum to melt special metals such as titanium, zirconium, tantalum, molybdenum, columbium, beryllium and vanadium. A company to commercialize this process has just been formed jointly by Stauffer Chemical, Temescal Metallurgical and Mallory Sharon Metals (the last named company is owned ⅓ by U.S.I.).

Techniques have been developed which permit certain impurities to be volatilized and removed, yielding metals of unusually high purity with properties not attainable by other methods. The process will make these high purity metals available for the first time in commercial quantities.

In this process, heat for melting is supplied by an electron gun which serves as the cathode and bombards the melt stock (the anode) with electrons, heating it to the melting point. Molten metal drops into a water-cooled

MORE

AEC Plans Another Sodium-Cooled Reactor Experiment

The Argonne National Laboratory has announced that a second Experimental Breeder Reactor (EBR-II) will be constructed at Arco, Idaho. It will be sodium-cooled with an electrical power output rated at 20,000 KW, and is expected to go critical in June 1959. Arco is also the site of Experimental Breeder Reactor-I, which is cooled with a sodium-potassium mixture and has an output of 15,000 KW.

The purpose of EBR-II will be to develop engineering and operation information which can be applied to full-size, central-station power plants. This reactor will contain complete fuel processing and fabrication facilities, heat transfer systems and steam electric plant.

Metallic sodium makes an excellent coolant because of its relatively low neutron-absorbing characteristics, good heat transfer properties, low melting point and high boiling point. High temperatures without high pressure can be produced when sodium is used as coolant.

MORE

New Coating Protects and Decorates Polyethylene

Films and molded products made of any type of polyethylene can now be decorated and/or protected with a new synthetic coating which is applied by dip or spray techniques. The material, tradenamed NYLENE, is reported to impart a hard, glossy finish and to increase clarity of polyethylene products. Excellent adhesion, flexibility and scuff resistance are claimed, along with resistance to a wide range of solvents. The new coating also acts as a vapor barrier.

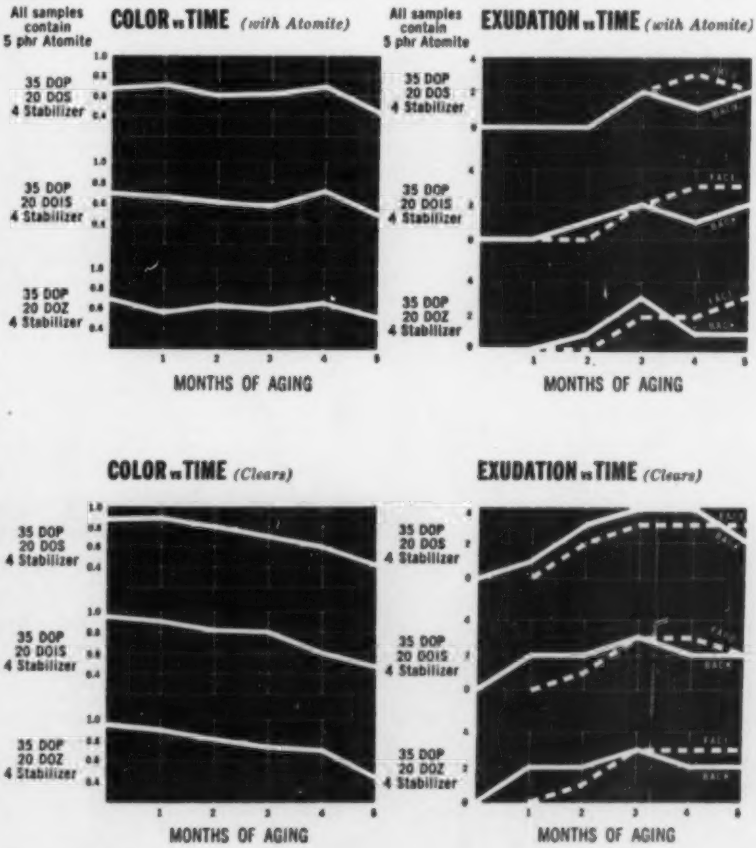
Because the coating can be tinted in any color, and combined with metallic powders, it is suggested for decorative purposes.

Advantage of Isosebacate Plasticizers Shows Up in Aging Tests on Vinyl Film

Dioctyl Ester of ISOSEBACIC® Acid Comparable to Corresponding Esters of Sebacic, Azelaic Acids in Performance, Lower in Cost

A five-month series of aging tests was conducted recently in Southern Florida by an independent research laboratory to determine color stability and exudation rates in vinyl films containing various plasticizers. In these tests it was demonstrated that the dioctyl ester of ISOSEBACIC acid is comparable in performance to the same esters of sebacic and azelaic acids when used as vinyl plasticizers. At the same time, the ISOSEBACIC acid ester is lower in cost.

The charts below show actual test results. ISOSEBACIC acid, a mixture of C-10 dibasic acids, was developed in the U.S.I. research laboratories. A commercial plant for production of this intermediate is being started up at U.S.I.'s Tuscola, Ill. chemical complex. Samples are available on request.



Note: 1.0 = Colorless

Charts courtesy of Deecy Products Company

June ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Electron-Beam Melting

copper crucible below and is not contaminated by the crucible.

Electron beam melting is said to offer several important advantages over vacuum arc melting. Operations can be stopped and started at any time. Materials can be melted in any form: ingot, powder, flake or sponge. Under the conditions existing in the furnace, gaseous impurities are removed rapidly as suboxides to leave behind the pure metal.

The process can also be used for zone refining. There is no apparent limitation on the diameter of the bar or ingot that can be processed, and so a large quantity of purified metal can be turned out in a relatively short time.

The new process will be licensed to interested industrial and research concerns.

Non-Beverage Alcohol Regulation Clarified

A new ruling by the Alcohol and Tobacco Tax Division of Internal Revenue clarifies a 1956 regulation concerning the filing of alcohol formulas when a company changes ownership. Revised Ruling 58-123 states that when a non-beverage manufacturing operation undergoes a change in proprietorship, and the new owner wants to use the alcohol formulas filed by the preceding owner, he must follow one of two procedures.

He can submit new formulas in his own name on Form 1678, Formula and Process for Non-Beverage Product, to replace those submitted by his predecessor. Or he can adopt the formulas already on file by submitting an affidavit to the Assistant Regional Commissioner, Alcohol and Tobacco Tax, stating that the preparations covered by formulas submitted by the prior owners, and on file with Internal Revenue, will be made in accordance with such approved formulas and processes.

The affidavit must identify the formulas by serial numbers and names of products. The original and two copies go to the Assistant Regional Commissioner who sends one copy to the Director, Alcohol and Tobacco Tax Division. A fourth copy should be retained by the manufacturer.

CONTINUED

Sodium in Reactors

Four other U.S. sodium-cooled reactors range in status from operational to the development stage. They are:

Sodium Reactor Experiment, Santa Susana Mts., Cal. — sodium-graphite reactor — 7,500 KW (operational)

PRDC Fast Power Reactor, Monroe, Michigan — fast breeder reactor — 100,000 KW (under construction)

Consumers Public Power District, Hallam, Neb. — sodium-graphite reactor — 75,000 KW (design stage)

Chugach Electric Association Reactor, Anchorage, Alaska—heavy water-moderated, sodium cooled—10,000 KW (development stage)

Chemical P.A.s Meet With Market Research Group

The Chemical Buyers Group of the National Association of Purchasing Agents met for the first time with the Chemical Market Research Association in Washington recently.

It was felt that market research groups can help P.A.s in major purchasing decisions, particularly in the "make-or-buy" area. Chemical buyers said that today they need information on distribution, consumption and future market trends as much as skill in negotiation in order to make intelligent, profitable purchasing decisions.

Conversely it was felt that P.A.s can give market research men data on current conditions, for developing market forecasts.

SOLOX® Denatured Alcohol Proves Versatile on Boats

With the boating and fishing season now getting into high gear, U.S.I.'s general purpose denatured alcohol solvent SOLOX is becoming increasingly popular with boat owners and campers. SOLOX has many cleaning uses — for wiping off sanded wood before painting, to dry the wood and clean out dust at the same time; with soap to wash painted surfaces; with water for cleaning glass; full strength for cleaning motors and ignition parts.

SOLOX is also an efficient fuel, and igniter for fuel, in boat and camp stoves.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Triethylborane is now being supplied in sample quantities for study as a catalyst for polymerization of unsaturated monomers, as a jet fuel or fuel component, and as an igniter or flame-speed accelerator. **No. 1360**

Equipment for radio-active operations is described in a new book now being sold. The volume contains some 60-odd papers delivered at the Hot Laboratories and Equipment Conference held as part of the 1957 Nuclear Congress. **No. 1361**

Thermoplastic adhesive in dry, 100% solid, continuous cord-like form, is now being marketed with applicator especially designed for controlled feeding, melting and applying. Claimed to bond polyethylene films, coatings, papers, boards, foils, glassines at 250 ft./min. **No. 1362**

Air pollution is the subject of a free, 20-page booklet just issued to help develop fair and workable air pollution laws. Principles essential to such legislation are defined. Procedures for formulating these laws are outlined. **No. 1363**

New corrosion-resistant, thermosetting coating for chemical plant floors is said to resist strong acids, alkalis and solvents, withstand temperatures of 230 F, support heavy traffic. Sets quickly to durability of good concrete. **No. 1364**

Carbon-14, tritium and sulfur-35 samples in solid, liquid and vapor phases can be measured for radioactivity with new dynamic condenser electrometer. With flow chamber, instrument claimed ideal for industrial gas monitoring. **No. 1365**

New adhesive for laminating urethan foam and combining it with all types of surfaces is said to impart immediate high tensile strength and excellent adhesion in heat or pressure-sensitive sealing. **No. 1366**

Encyclopedia of Chemical Technology has just been brought up-to-date through issuance of the first supplement volume to this series. It contains 51 articles covering, among other topics, adhesives, computers, nuclear reactors. **No. 1367**

New portable oxygen indicator is now available for measuring concentrations of oxygen in gaseous mixtures from 0 to 25% by volume. Operates on a single flashlight battery, weighs less than six pounds. **No. 1368**

Zirconium and hafnium technical and application data are covered in a new 16-page brochure now available at no charge. Production, properties and mill shapes available are included, as well as present and future commercial uses. **No. 1369**

PRODUCTS OF U.S.I.

ORGANIC SOLVENTS, INTERMEDIATES

Plastics Intermediates: ISOSEBACIC® Acid, Sebacic Acid.

Alcohols: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil.

Esters: Ethyl Acetate (85-88%, 95-98%, 99%), Normal Butyl Acetate, Diethyl Carbonate, DIATOL® (Diethyl Carbonate Containing About 10% Anhydrous Ethanol), Diethyl Oxalate.

Ethers and Ketones: Ethyl Ether (Technical, Absolute, USP), Acetone (Dimethyl Ketone).

Intermediates and Fine Chemicals: Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, 2-Ethyl Heptanoic Acid.

OTHER PRODUCTS

Alcohols: Ethyl (pure and all denatured formulas): Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

PETROTHENE® Polyethylene Resins

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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institutional news

2nd National A.I.Ch.E.-A.S.M.E.

Heat transfer conference

and Exhibit

Chicago's luxurious Edgewater Beach Hotel will be conference site, August 18-20, 1958.

At the Conference—three full days emphasizing the industrial and practical aspects of heat transfer. At the Exhibit—the latest in equipment and design features, by major manufacturers.

Among the outstanding items on the program will be the latest Oak Ridge result on heat transfer in vortex flow with heat fluxes considerably greater than any previously measured coefficient (said to be more than 30 million BTU/sq. ft./hr.). There will be a practical correlation of nucleate boiling with a highly simplified recognition of the dominant factors which have been the background for the design of literally hundreds of vaporizers. The understanding of the geometry of surface-bubble formation, the temperatures of the surface, and the rate of growth of bubbles, will be dealt with at length.

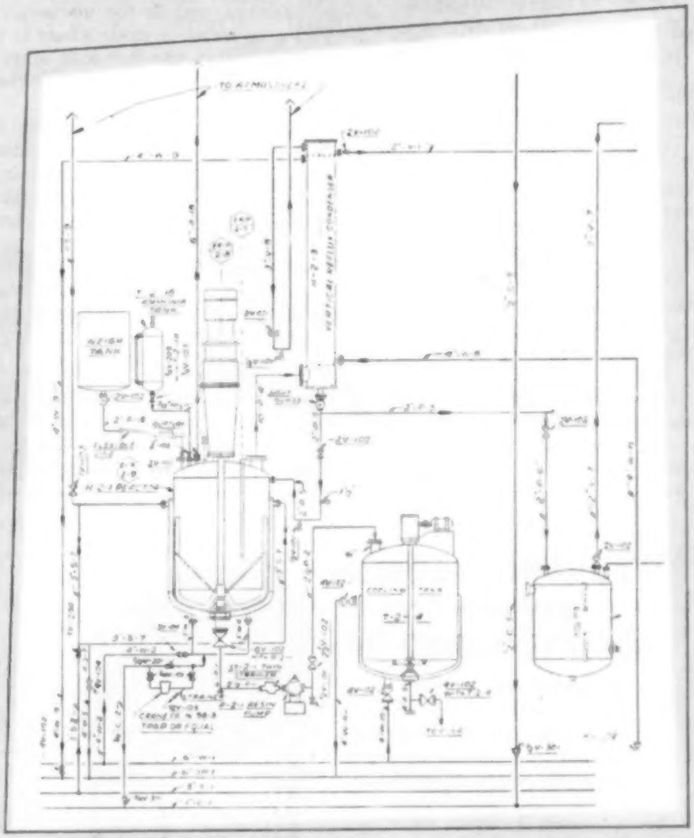
A better understanding of phase changes in a stream flowing in a tube should result from studies of condensing heat transfer inside tubes.

An important report based on practical experience of Shell Chemical in using high velocity forced circulation in reboilers will be welcome knowledge for many engineers. And high density radiant heat will be analyzed by an engineer from a company which has pioneered in the building of gas burners for concentrated radiant heating. On mechanically-aided heat transfer, engineers will hear how a successful start has been made in analyzing the forces and behavior of materials being agitated or scraped on the heat transfer surface.

Plan your August "vacation" at the Edgewater Beach.

Phenolic Resins...

with an almost unlimited range of properties!



Flexibility is the key word in Phenol-Formaldehyde plants designed and constructed by I★P★E. The equipment is designed to allow for process variations such as the ratio of phenol to formaldehyde, the type of phenol, the type of catalyst and the length of time allowed for condensation. The processing steps depend on the end use for which the resin is intended, be it molding compound, surface coating, or adhesive.

For further details on this process, or on any resin plant, contact I★P★E's Process Plants Division, Dept. B.

INDUSTRIAL PROCESS ENGINEERS

12 LISTER AVENUE • NEWARK 5, N. J.

Helium demand up 600% in ten years— New process may be key to supply

Helium may be the next industrial gas to be produced in large commercial quantities, joining oxygen, nitrogen, acetylene. This is the promise of a new method developed by Bell Labs for separation of helium from natural gas by diffusion through glass capillary tubes.

Present U. S. helium production is around 200 million cubic feet per year; latest Census Bureau figures for 1954, 1955, and 1956 show 191, 221, and 191 million cubic feet respectively—small indeed compared to production of 22,108 million cubic feet of tonnage oxygen in 1956. Almost all U. S. helium is now produced at four government-owned Bureau of Mines plants at Amarillo and Exell, Texas, Otis, Kansas, and Shiprock, New Mexico.

While supply lags, demand is soaring. In addition to non-commercial uses such as weather ballons, etc., helium is used in increasing quantities for shielding in arc welding, as a blanketing gas in processing zirconium and titanium, and in the mechanical welding of stainless steels where it is said to be more effective than argon, the other inert gas used for this purpose.

Helium resources are no problem; estimated daily loss is 10 million cubic feet in burning of helium-containing natural gas. Brakes on large-scale production up to now have been low helium content in the natural gas (often under 1%), and the economics of the low temperature distillation process now used for recovering the helium.

How Bell does it

Selective diffusion through a thin layer of silica glass is the secret. Diffusion rate increases rapidly with temperature; projected operating temperature is 400°C. A second must for rapid diffusion is a high pressure differential. Bell has found that thin silica or Pyrex tubing fills the bill perfectly on both counts; it will stand temperatures well over 400°C, and

K. B. McAfee, Bell Telephone Labs, holds bundle of capillary tubes of type used in newly-developed helium diffusion cell.

continued on page 110

PUMPING PROBLEM GIVING YOU TROUBLE?

Get *qualified* help.
Tell us about it.
SK Gear Pumps, product of years of research and engineering experience, are solving problems in almost every industrial field—pumping many types of materials like alcohol, fuel oils, glue, wax, lube oils, resins, cellulose, heated oils, road tars. Some applications require only a top-quality standard pump. Ours are top-quality. Other applications demand something special. If so, we're ready to cooperate.

We'd like to get acquainted—let us send you Bulletin 17-A describing our pumps and engineering service. Just write us. We'll send it.

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FLEXROCK TEFLON* PACKING no. 405

Constructed of fine Teflon fibers tightly braided over a resilient core of glass fiber and impregnated with Teflon. Flexrock 405 is an excellent chemical packing. It is especially recommended for use against concentrated acids such as sulphuric, nitric, sodium hydroxide; alkalies, etc. Flexrock 405 Teflon Packing has a maximum temperature range of 500°F., and comes in sizes of 5/16" to 1". Smaller sizes available with solid core.

*DuPont's trade name for tetrafluoroethylene

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Please send additional information on Flexrock 405 and other Teflon Packings.

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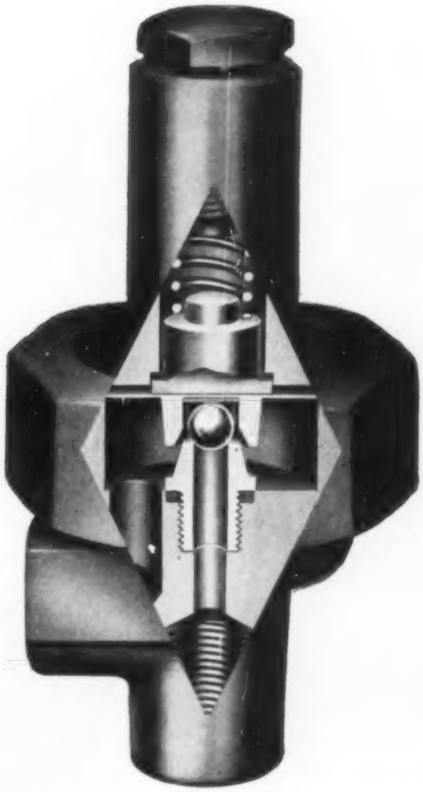

Take a second look

At a Milton Roy Chemical Relief Valve

Leakproof construction in steel, 316 stainless steel, Carpenter 20 stainless, Hastelloy "C" or "B" available from stock. Top works protected by Kel-F or Teflon diaphragms. Specify Milton Roy relief valves for pressures to 1500 psi. Sizes: ¼", ½", ¾", and 1".

Corrosion resistant back pressure valves, with Teflon diaphragms, are available for service at pressures to 200 psi.

Guard the accuracy of your Controlled Volume Pump—protect your process equipment . . . write for detailed information to Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania. Engineering representatives throughout the world.

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CHEMICAL INSTRUMENTATION SYSTEMS

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25-20 Casting with Welded Assembly

This is a separator destined for a reaction process. It is typical of the kind of work we do in the high alloy casting field. In the 25 Cr-20 Ni range it is alloyed to withstand both corrosion and heat. Assembled, its weight runs some 2000 pounds. It was inspected and tested under very rigid ASME Code requirements.

The production of chrome iron and chrome nickel castings has been our sole business since 1922. We added centrifugal castings to our service in 1933 and shell molded castings in 1955. Our metallurgists have extensive knowledge of the many operations requiring high temperature and corrosion resistant castings. Perhaps this experience would be helpful to you if you are confronted with a specific problem and wish to determine the best alloying combination for your required castings. We can be helpful, too, in designing the unit, contributing our knowledge of strength and stresses in castings.

The DURALOY Company
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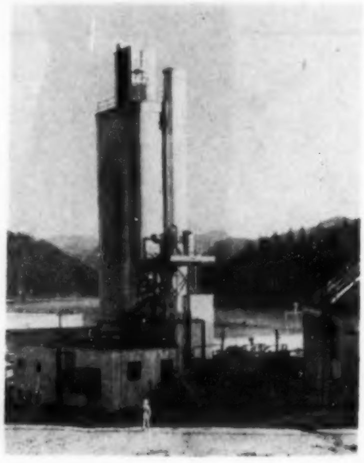
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Major expansion at chemical cellulose mill

Betting on the future growth in chemical cellulose needs, Alaska Pine & Cellulose, a Rayonier subsidiary, has just come on stream with a $14 million expansion and modernization of its Port Alice, B. C., mill.

Despite present depressed business conditions in chemical cellulose, Alaska Pine & Cellulose has gone ahead and completed the modernization and expansion program which makes the Port Alice, B.C., mill all but a new plant.

One of the company's major goals was quality. With the new facilities, the Port Alice mill will be able to produce the highest grades of chemical cellulose needed by the chemical industry for such products as viscose and acetate materials, cellophane, tire cord, and photographic film and papers.



The new Jenssen Acid Towers at Port Alice cellulose plant.

Combined with the increased quality, the expansion program has upped Alaska Pine's capacity at Port Alice from 75,000 tons to 125,000 tons a year. End result of the program is that the Port Alice plant is now ready to produce larger quantities of the highest grades of chemical cellulose and assure a firm supply for any chemical producer in the field, or contemplating entry into the field.

continued on page 110

STAINLESS STEEL
produced the way *you* want it by Carlson

Only at Carlson can you buy so many grades of stainless steel in the wide variety of shapes and sizes illustrated here. We regularly process such complete bill-of-material orders. Trained Carlson men, with years of experience and practical knowledge, are determined to give you the best and most efficient service possible.

When you need stainless plate . . . Carlson gives you what you want when you want it!

Write for CARLSON'S WEEKLY STOCK LIST . . . your guide to what's available in high-quality stainless steel.

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124 Marshalton Road
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STAINLESS STEEL PLATE . . . rolled to almost any size or thickness, 3⁄16″ and heavier, to meet your individual needs—whether rectangles, circles or special patterns. Substantial tonnage in Types 302, 304, 304-L, 309, 309-S, 310, 316, 316-L, 317, 317-L, 321, 347, 348, 405, 410, 430 and 502-½% Mo. is available for prompt delivery. In addition, two precipitation-hardening grades, Types 17-4 PH* and 17-7 PH* are now in production.

STAINLESS STEEL HEADS . . . in Types 304, 304-L, 316 and 316-L are available from stock in ASME and Standard specifications (10″ to 72″ diameter). A large assortment of dies is available for pressing other types of heads and special sizes can be spun where practical.

STAINLESS STEEL FORGINGS and SPECIAL PATTERNS . . . including tube sheets, flanges, circles, rings, sketch plates and other specialties can be produced to specification on our versatile equipment.

Also STAINLESS STEEL BARS AND SHEETS (No. 1 Finish).

*Trade mark of ARMCO STEEL CORPORATION

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS and SHEETS (No. 1 Finish)

NEW

"Varec"

PULSE CODE

. . . telemetering System

For the remote reading of

P. D. Meters

HIGH SYSTEM CAPACITY – 99 identification numbers and 6 digits of data (one million counts – Barrels, Gallons – etc.).

ACCURATE to one point in one million for a 6 digit unit.

HIGH INPUT RATE – 18,000 counts per hour (max.).

FAST READ OUT time – only 7 seconds required to obtain a reading.

SLOW PULSE RATE of 5 per second – Does not require high grade telemetering channel – All parts operate well within ratings.

DIGITAL OUTPUT of receiver unit suitable for data logging or other data handling functions.

TRUE DIGITAL Pulse Code type of transmission.

"ERROR CHECKING" TYPE of code practically eliminates the introduction of errors by telemetering channel abnormalities.

TRANSMISSION (read out) may take place during change in measurement (P.D. meter can be running). The transmitter does not have to be "locked", nor is the use of other methods necessary to prevent ambiguous readings.

SYSTEM AND EQUIPMENT not limited to telemetering of single type of measurement – transmitters/convertors available for liquid level, temperature, pressure, etc. System arrangements available as accessory features for remote control functions, data logging and alarm signals.

RELIABLE – no vacuum tubes or other expendable parts are used; all components are rugged and used well within applicable ratings.

Request Bulletin CP-3701

561-29

"Varec"

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chemical cellulose

from page 108

At present, Alaska Pine spokesmen admit, there is over-capacity in the chemical cellulose field. Primarily this is the result of sharp import restrictions by Japan, a major market for such west coast plants as Port Alice, and considerable curtailment in the North American textile industry. The market picture now is not strong.

The company estimates that it will take at least 18 months before the new grades, and increased capacity, will result in significant new business. But despite the definite condition of over-capacity now, the company is optimistic.

Reason for optimism is the long term prospect for chemical cellulose. All economic studies and estimates point to a sharp increase in world use of products made from chemical cellulose, and the company is planning for the long term, for which Port Alice will be ready.

New equipment

Alaska Pine claims that Port Alice is now "one of the finest mills of its kind in the world." The program included the installation of a new pulp drying machine, and a finishing room with cutter, lay-boy and high pressure bailing presses. Two digesters have been added as well as a large new boiler and a 6,000 KW turbo-generator. Changes have been made in the Bleach Plant to improve quality, and new equipment has been added to the screen room to handle the increased production.

A new Acid Plant has been built, and a car-barge slip has been constructed to facilitate bringing in the necessary chemicals.

helium process

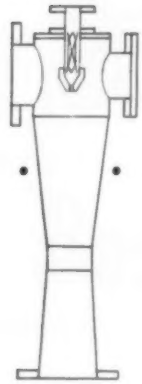
from page 106

pressure differentials in excess of one thousand atmospheres.

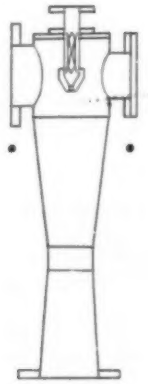
Experimental data indicates that a cell containing enough capillary tubes to occupy about two cubic yards would permit recovery of 100,000 cu. ft. of helium per day at 400°C and 1,000 atmospheres assuming 1% helium in the natural gas passed through the cell. Such a cell might be placed directly in a gas pipeline.

Product purity by the new method is extraordinary; analysis indicates less than 0.0009% hydrogen content in a single pass.

Quizzed as to immediate commercialization plans, Bell said that no commitments had been made as yet.



CROLL-REYNOLDS
Jet-Venturi
Fume Scrubbers



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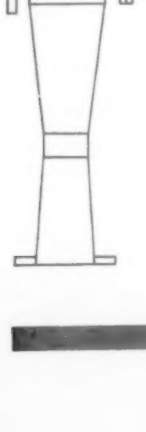
and other gases
without fan or blower



ADDITIONAL APPLICATIONS

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Sharples advanced design centrifuges set new standards of performance, flexibility of operation and range of capacity.

There are many specific facts that warrant the close scrutiny of those to whom the purchase of new plant equipment must be an outstandingly profitable capital investment.

Compare the new Sharples 1958 lines with the best you have experienced heretofore—and be convinced.

Sharples 1958 Nozljectors—A series of nozzle type disc bowl centrifuges with feed capacities up to 400 gallons/minute; up to 125 HP drive.

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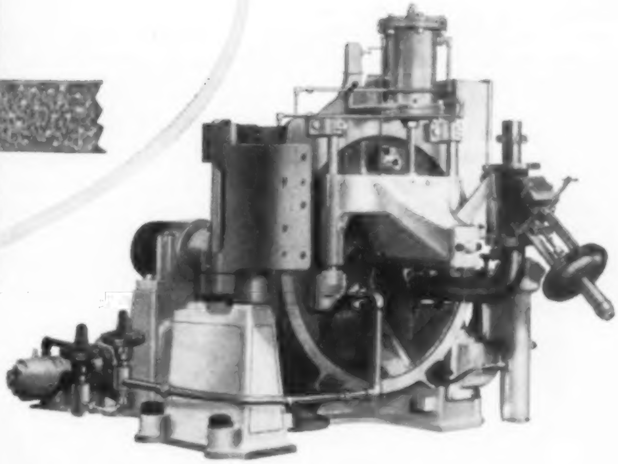

Sharples 1958 Super-D-Hydrators—A line of high efficiency crystal dehydrators with capacities ranging from 1 to 2 tons of crystals/hr. up to 20 tons or more/hr.

Sharples 1958 Super-D-Canters—Models for dewatering solids at feed rates as low as 1 gpm up to 250 gpm; solids discharge rates from below 25 lbs./hr. to approx. 12 tons/hr.

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Woven Wire Conveyor Belts as a Processing Tool

Use of woven wire belts in chemical processing is expanding. Here is a description of the main types available, their respective advantages, and suggestions for their application to your particular process problem.

J. F. Reid
Cambridge Wire Cloth Company, Cambridge, Maryland

Although woven wire conveyor belts as a medium for combining movement with processing are widely used in other industries, they are only now beginning to find as wide usage in the chemical process industries. Peculiarly, though, one of the first woven wire belt installations made in this country was in a chemical plant. This was a belt installed in festoon fashion in a pigment manufacturing plant and its purpose was to dry freshly formed pigment. The pigment was actually impregnated into the open mesh of the belt and slowly conveyed through the festoon formation where warm air performed the drying operation.

Today this processing tool is widely used for **combining movement with processing** of pelletized materials, sheet materials, slab materials as well as for filling, packaging and inspection of products of the chemical process industry.

Nine basic constructions are available in woven wire belts. Each is identified as a "weave" and there are countless variations as to mesh size, wire size, etc., within each weave. Thus, they can be designed specifically for practically any application and, in a sense, are truly custom-made.

Of the nine basic weaves, three are most frequently used in the chemical process industries. These three and their inherent characteristics and advantages are:

Rod-reinforced weave — Has low thermal capacity and high tensile strength, provides straight belt travel. These make it extremely useful in high temperature installations ranging up to 2,100° F. when woven from the proper alloys.

Balanced weave—This is the most popular of all belt weaves because it is the lowest in ultimate cost. It has high tensile strength and is resistant to distorting strains. Straight-belt travel is also another important feature and this construction is considered the easiest of all belts to control. Temperatures up to 1,400° F. are permissible with a Balanced belt.

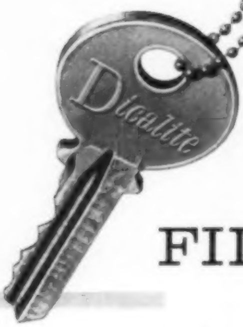
Duplex Weave—This is used mostly for exceptionally heavy loads or where a smooth, close mesh is required. Because the Duplex weave is rod-reinforced, it provides maximum tensile strength and other qualities essential for satisfactory high-temperature operation.

Generally speaking, woven wire conveyor belts might be said to possess six inherent features that make them worthy of consideration over other types of conveyor belting.

- Because they are all metal and can be woven from any metal or alloy, they can be used throughout a wide range

continued on page 116

When things get tight...



this can be your key to FILTRATION ECONOMIES

Perhaps you are concerned with filter cycles which seem too short . . . or you may be wondering if the grade of filteraid you use is the optimum for your purposes. Are you satisfied with flowrates and clarity? These are among the questions which the Dicalite field service engineer will answer when he works with you to re-evaluate your filtration operations.

An expert in filtration to begin with, the Dicalite engineer has broadened his knowledge by first-hand familiarity with the filtration problems of a wide range of industries . . . experience which can often translate operating practice in another application into new efficiency for your filter station. The helpful counsel of the Dicalite engineer is yours without obligation.

Also, when economy is in question, today's Dicalite filteraids can be a powerful aid. Through continuous quality-improvement work, a Dicalite filteraid now gives greater filtration efficiency than was possible only a few years ago — even though it still bears the same grade name!

Taken together, these two — Dicalite filteraids and Dicalite engineering service — can aid you to maximum filtration effectiveness at minimum cost. Write us, today, for information on both.

Among the DIATOMS shown here:

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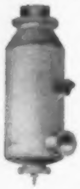

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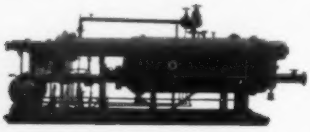

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Operating reports on units now in service show perfect CO_2, no excess air, no unburned combustibles, wide turndown, and completely dependable flame stability. Specially engineered to your specifications.

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The John Zink line of process equipment also includes the famous JZ Smokeless Field Flare, Waste Disposal Units, and more than 50 gas, oil and combination gas and oil burners. Special burners and process equipment designed for your individual application.

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COMPANY
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Woven Wire

from page 114

of temperatures ranging from sub-zero requirements up to 2,100° F. The all-metal construction can be made of high-alloy materials which means that the belt is impervious to damage from moisture, acid sprays or other corrosive conditions. They can be woven with practically any gauge of wire from 3 W&M to 32 W&M.

• The open mesh construction of the belting means that there are no solid surfaces to block heat circulation during drying or heating or cold circulation during cooling or freezing. Process atmospheres circulate freely through the openings in the mesh, allowing for faster, uniform processing of the load. They can be woven with mesh openings ranging in size from 1/64 in. to 2½ in. and even greater.

• Open mesh construction also means that process solutions or wash solutions drain quickly and freely through the belt into discharge or salvage troughs mounted below. Wash water or spray rinses cannot become entrapped in the belt because of deterioration, rot or rust.

• There are no sharp edges to the wire and the mesh can be woven closely enough so that it won't catch and cut operators' fingers.

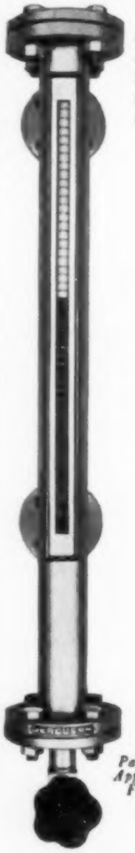
• The all-metal belt has no odor and can't pick up odors from the load being carried.

• There are no seams in a woven wire belt. The belt is connected or disconnected in the same way that it is made so that there are no weak points in the final assembly.

It is important to understand that woven wire conveyor belts are not just a conveying medium. They are a means of combining movement with processing. These belts can carry a load through washing operations, dewatering, cooking, cooling, blanching, heating, drying and practically any other type of process.

Applications of woven wire belts are by no means confined to straight-line operation. When the proper weave and specification is selected, the woven wire belt can take up to a 90° turn without buckling or twisting.

In selecting a woven wire belt, it should be remembered that no single construction will give complete satisfaction under all operating conditions. Each construction has individual and specific characteristics that render it most useful to certain installations. Therefore, successful and satisfactory woven wire belt engineering requires thorough coordination of specific service requirements, as well as the requirements of the product to be handled, size of mesh or opening desired and the size of wire and material in which the belt is to be woven.



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

For pressures up to 2500 lbs. @ 600° F.

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Can also be used for interface indication.

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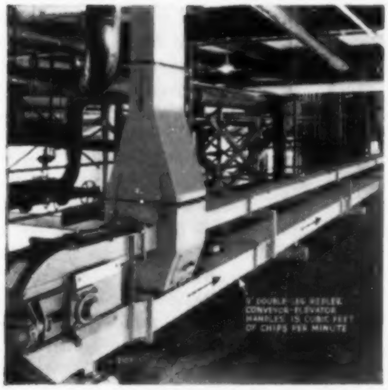
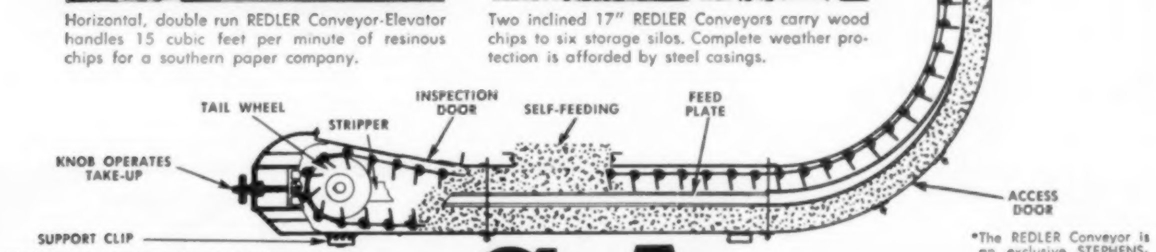
CONVEYORS-ELEVATORS

For safest, gentlest handling of your bulk materials... en masse!



Horizontal, double run REDLER Conveyor-Elevator handles 15 cubic feet per minute of resinous chips for a southern paper company.

Two inclined 17" REDLER Conveyors carry wood chips to six storage silos. Complete weather protection is afforded by steel casings.



DRAWING OF L-TYPE REDLER CONVEYOR-ELEVATOR

*The REDLER Conveyor is an exclusive STEPHENS-ADAMSON product.

STEPHENS-ADAMSON

THE BIG NAME IN BULK MATERIAL HANDLING EQUIPMENT

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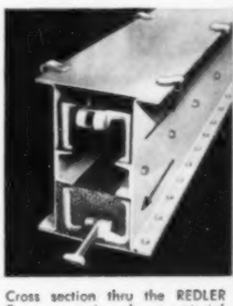
PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO

The REDLER Conveyor-Elevator is one of the most remarkable bulk materials handling machines ever built. It will move practically any pulverized, granular, small lump, or flaky material around corners, over vertical, inclined, or horizontal planes. Material moves forward in a compact column within a totally enclosed, dust-tight casing which virtually eliminates explosion hazards. Material is moved by means of closely spaced skeleton type flights linked together and moving through the casings. Material flows forward in a compact column. A very useful feature of the REDLER Conveyor is its ability to discharge material at multiple points. Arranged as a horizontal closed-circuit unit, the REDLER Conveyor will re-circulate materials and is often used in packaging or distributing operations.

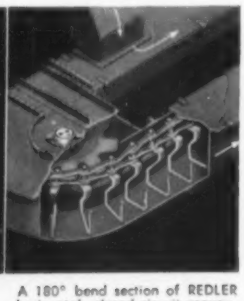
Compact REDLER Conveyor-Elevator designs are available in sizes to handle almost any tonnage. They are quickly and economically installed and their rigid box-girder-like casings are practically self-supporting. For complete data on REDLER Conveyors and Elevators, write for catalog 556.

S-A district or main plant offices can supply complete information on any conveyor product, or any phase of bulk material handling. Request a copy of REDLER catalog 556 for your file.



Cross section thru the REDLER Conveyor casing shows material being conveyed in a lower run and the empty flights returning in upper run to complete the circuit. The casing is completely dust-tight, is largely self-supporting and requires very little space.

Exclusive, skeleton type flights linked together to move materials forward in a steady, non-agitated flow. REDLER flights readily curve around corners permitting horizontal and vertical movement of materials with one unit and one drive.



A 180° bend section of REDLER horizontal, closed-circuit conveyor. Sprocket drives side-pull style chain and flights around the bend. Ley bushed type driving chain is supported in a separate trough — no metal to metal contact in conveying chamber.

State-wide Oklahoma meeting

Process plant instrumentation, professionalism, engineering education, high energy fuels, radiation processing, and economic nuclear power were all analyzed at a joint one-day technical meeting of the **Oklahoma, Central Oklahoma,** and **Tulsa** sections *(R. L. Rorschach)* at the Univ. of Tulsa, April 12. At the luncheon, Edgar Piret of Minnesota Univ. described some of his impressions of Soviet education and research. Among Piret's statements was his opinion that Russia is still 10-15 years behind the U. S. in concepts and technical developments in the chemical engineering field. He added, however, that there is no reason for us to feel self-satisfied about this. They are putting a tremendous effort into this field, and they are capable of catching up.

In answering questions following his presentation of the subject of professionalism, J. J. McKetta said he thought that engineer's unions would probably be of value only to engineers who had given up all hope of ever gaining anything on their own merits, or by their own efforts. He closed with the thought that the man in the street will never look upon engineering as a profession until the majority of engineers consider themselves to be professional men, and act as such. Taking issue with McKetta on the subject of professionalism, R. R. White of Michigan Univ., said that he didn't think engineering would ever quite achieve the same standing with the public as the medical and legal professions because the ingredient of personal service to the individual was not as pronounced. It would be possible, he continued, for engineers to achieve an honored place in the public esteem without the emotional appeal of the older professions. To this end, he proposed a change in emphasis in engineering education which would produce a more competent and professionally minded graduate. He suggested curricula consisting essentially of non-specialized engineering, science, mathematics, and humanities courses leading to a Bachelor's degree in Engineering; specialization, if desired, to take place at the graduate level.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ANTHRAFILT
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"the modern filter medium"
USED BY LEADING COMPANIES FOR:

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ANTHRAFILT, being essentially a pure carbon is not affected by acid or alkaline solutions.

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A flexible compact unit that combines a powerful disperser head with a rugged diamond-shaped agitator to produce finished homogeneous batches without further processing—for most chemicals, inks, plastics, pharmaceuticals, cosmetics, paints, and industrial finishes.

Modern design gives high degree of shear, kinetic impingement, and complete mulling action for better wetting, improved dispersion, and uniform blending. Small size laboratory models available.

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Kansas City one-day meeting

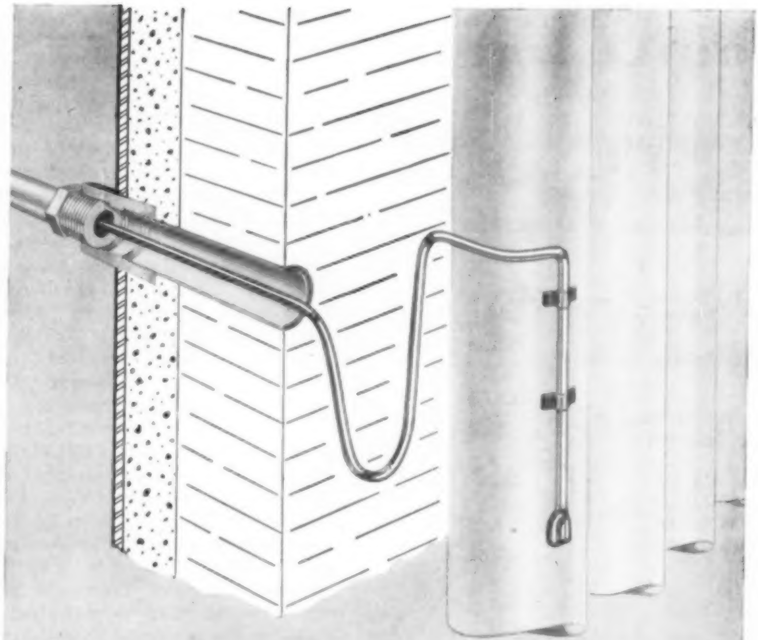
The day-long meeting of the **Kansas City** section *(J. D. Howland & J. C. Daly)* took place March 22 at the Linda Hall Library of the Univ. of Kansas (one of the few scientific libraries in the U. S.). The presentation of student papers was a unique feature of this technical meeting. The processing of natural gas to remove H_2S & CO_2 was dealt with by D. P. Sobocinski who described procedures for obtaining equilibrium data of the H_2S-CO_2 system to form the basis for a practical low-temperature distilling process. Another process for purifying natural gas by freezing out impurities was alluded to by J. Brewer. Both speakers are graduate students working under Fred Kurata at Univ. of Kansas.

The Tower of Babel of United States scientific literature was described by J. C. Shipman, Chief Librarian of the Linda Hall Library. He showed how the disorganized state of the accumulated scientific literature in this country could cause strangulation of scientific advancement. Pointing out that the cost of abstracting the tremendous morass of technical information is being borne by the technical societies, he suggested that a possible disentanglement solution might be a National Documentation Center which could control bibliographies, mechanically translate, microreproduce, analyze, store and retrieve scientific material. Other presentations included: B. J. Duffy, Jr.–discussed errors made in design of fractionating equipment due to lack of communication between engineers; L. G. Stevenson–related a case history of problems encountered in operating a high pressure pilot plant; W. E. Clark–reported a study of combustion of methane and air to permit calculation of the concentration of reaction products under given conditions; R. C. Hall–described a solution to the problem of stickiness in dehydration of potatoes as a sample unit operations problem; and D. L. Kloepper–reviewed the steps in the current problems of processing uranium ore to fuel.

Philadelphia-Wilmington meeting

Those **Philadelphia - Wilmington** members really make their weight felt. They were co-sponsors of the annual

continued on page 120



Ceramo® Thermocouples For Furnace Tube Walls

Cut Installation Time 75%

Installation time, always a high-cost factor with furnace tube wall thermocouples, has now been reduced up to 75% by Thermo Electric. Responsible for this reduction is T-E's "Ceramo" construction—ceramic-insulated conductors with overall metal sheathing. Conventional, rigid assemblies were both costly and difficult to install. "Ceramo" furnace tube wall thermocouples virtually eliminate these difficulties.

Applications

These thermocouples measure the increase in outer tube wall temperature when coking or scaling of the inner wall causes a loss of heat transmission. They are used on furnace tubes, superheaters, pre-heaters, and for determination of start-up temperatures.

Advantages

"Ceramo" furnace tube wall thermocouples can be bent to almost any shape—greatly simplifying difficult installation around tubes.

Large holes in the furnace wall, previously required to accommodate the motion of old-style, rigid assemblies, are no longer necessary. "Ceramo," though basically rigid, will flex with the differential motion between tubes and furnace wall. "Hot spots," resulting from faulty insulation around large, rigid assemblies, are also eliminated.

Since "Ceramo" measuring junctions are completely enclosed, they need only be tack welded to the tube wall. There's no need to seal-weld the entire outer end of conventional, open-end protection tubes. "Ceramo" is generally used *without* protection tubes.

"Ceramo" construction provides extremely small O.D.'s—ranging from 1/16" to 7/16".

Write For Bulletin EDS-54-V

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

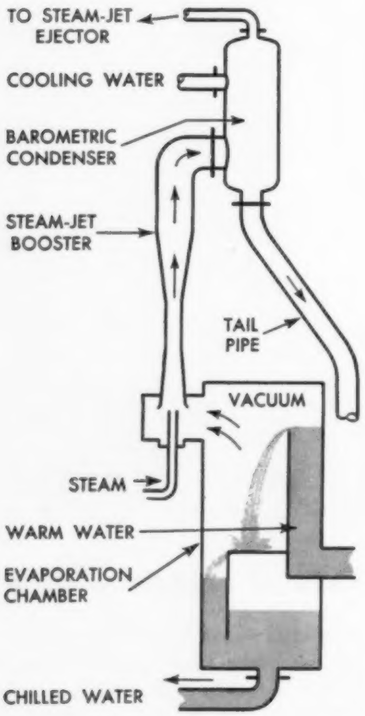
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

How to

CHILL WATER

With

STEAM



I-R Steam-Jet Coolers chill large volumes of water down to temperatures as low as 35 F, with no power but *steam*—and no refrigerant except *water*. The simplicity, economy, dependability and safety of water-vapor refrigeration makes it the ideal solution to process cooling problems wherever steam is available.

The cooling action is achieved by *evaporating* a small portion of the water to be chilled, in a vacuum chamber which is evacuated by a steam-jet ejector. The ejector can discharge into either a barometric or surface condenser. Overload capacity is higher than with any other system. And no special foundations nor vibration-isolating devices are required.

Send for Bulletin No. 9143-B

IR

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from page 119

Del-Chem (science) Symposium *(W. Schotte)* at the Univ. of Delaware, Feb. 15, and followed up with their annual All-day technical meeting *(E. R. Westfield)* at the Univ. of Pennsylvania, April 8.

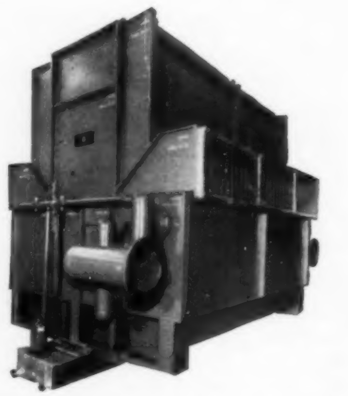
Five papers on various aspects of chemical engineering were given at Delaware. These covered equilibrium and kinetics, prediction of product compositions in fluid bed reactors, bubble-tray liquid mixing, heat transfer in dropwise condensation, and control of exothermic reactions.

A whopping 656 chemical engineers, representing about 100 companies and 8 universities, attended the April All-day technical session *(J. B. Maerker)* featuring Scale-Up in Practice. H. J. Ogorzaly of Esso Research discussed the factors justifying the operation and scope of pilot plants. This was followed by a brief review of Scale-Up theory and its limitations by A. B. Metzner & R. L. Pigford of Delaware Univ., showing that only the simplest industrial problems are capable of being scaled by the use of dimensionless numbers. Analog approaches to Scale-Up were explained by C. W. Worley of Electronic Assoc., who pointed out that the computer does not substitute, but only assists, the engineer's thinking. The morning session was concluded by Fred Knopf of Atlantic Refining with his description of pitfalls in Scale-Up.

During the noon luncheon, the three student winners of the annual F. C. Zeisberg Memorial Award for excellence in report writing were announced. In usual prize order, they were: Don Koestler, Villanova; Don Garaventi, Lehigh; and Les Cohen, Drexel. Economic and business aspects of Scale-Up occupied the afternoon session. D. J. Torrans (Hercules) discussed the process economics of Scale-Up. D. M. Feeley (A. D. Little) covered business economics of Scale-Up, and R. L. Hershey concluded with the requirements for the effective organization for Scale-Up.

Due to limited editorial space, the Toledo, Peninsular Florida, *and* New Jersey *One-day technical meetings will have to be reported next month. —Ed.*

ECONOMICAL COOLING OF GASES AND COMPRESSED AIR



Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130.

NIAGARA BLOWER COMPANY

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Niagara District Engineers in Principal Cities of U. S. and Canada


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85% THRU ISOFLOW HEATERS
...and "Isoflows" in five new Butadiene plants are additionally supplying 1,000,000 lbs/hr of superheated steam up to 1400° F
Butadiene capacity is mushrooming to meet the rising demands of synthetic rubber and chemicals. Of the new butadiene plants put into operation during 1957, Petrochem Isoflow Furnaces have been installed in the 5 largest, representing approximately 85% of the total increased capacity in the U.S.
Isoflow Furnaces efficiently perform two important heating functions, depending upon the butadiene process involved:
(A) To heat directly the butane-butene feed stock and steam to a high temperature for dehydrogenation.
(B) To supply highly superheated steam which in turn heats the butane-butene stock for dehydrogenation.
The unique design and operating features which have led to the wide acceptance of Petrochem Isoflow Furnaces include:
• Uniform Heat Distribution
• Maximum Fuel Efficiency
• Low Pressure Drop
• Low Maintenance
• Zero Air Leakage
• Minimum Ground Space
• Simplicity of Design and Construction
• Short Length of Liquid Travel
• Series, Multipass, all parallel flow
• Excess Draft for High Overload
For butadiene production, catalytic reforming or any other petroleum, petrochemical or chemical process there's a Petrochem Isoflow Furnace for any duty, temperature and efficiency.
PETROCHEM-ISOFLOW FURNACES
UNLIMITED IN SIZE ... CAPACITY ... DUTY
PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.
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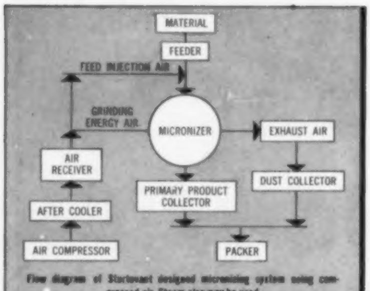
Need ½ to 44 Microns?

Sturtevant Micronizers* Make 325 Mesh Obsolete



Flow diagram of Sturtevant designed micronizing system using compressed air. Steam also may be used.

Production Model (15 in. chamber)

One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from ½ to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant •accessibility, easy cleaning. No moving parts.

Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (½ to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

Engineered for Special Needs

A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

Can Test or Contract Micronizing Help You?

Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 135 Clayton St., Boston, Mass.

*REGISTERED TRADEMARK OF STURTEVANT MILL CO.

future meetings

1958—A.I.Ch.E.

• Evanston, Ill., August 18-21, 1958. **A.I.Ch.E.-A.S.M.E. Heat Transfer Conference.** Edgewater Beach Hotel. Tech. Prog. Chmn.: A. S. Foust, Chem. Eng. Dept., Lehigh University, Bethlehem, Pa. For brief description of program see p. 105. Complete details in July CEP.

• Salt Lake City, Utah, Sept. 21-24, 1958. Hotel Utah. **A.I.Ch.E. National Meeting.** For further information see p. 96.

• Cincinnati, Ohio, December 7-10, 1958. Netherland Plaza Hotel. **A.I.Ch.E. Annual Meeting.** Genl. Mtg. Chmn.: T. B. Wiehe, Schenley International. Tech. Prog. Chmn.: A. C. Brown, Emery Industries, Inc. June & Long Sts., Ivorydale, Ohio. **Pollution Control by In-Plant Measures**—C. Fred Gurham, Dept. of Chem. Eng., Michigan State U., East Lansing, Michigan. **A.I.Ch.E. Research on Bubble Cap Tray Efficiency**—W. C. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. **High-Speed Photography in Chemical Engineering**—J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. **Kinetics & Rate Proceses**—H. E. Hoelscher, Dept. of Chem. Eng., Johns Hopkins Univ., Baltimore 18, Md. **Reprocessing of Fluid Reactor Fuels**—O. E. Dwyer, Chem. Eng. Div., Brookhaven National Laboratory, Upton, L. I., N. Y. **The Application of Computers to Heat and Mass Transfer Problems**—J. M. Smith, Northwestern Univ., Evanston, Ill. **Low Temperature Processing**—C. McKinley, Air Products, Inc., Allentown, Pa. **Scale-up from Pilot Plant to Plant**—D. B. Coghlan, Foote Research and Development Laboratories, Berwyn, Pa., R. A. Schulze, DuPont Chambers Works, Jackson Labs., Penns Grove, N. J. **Guideposts in Long Range Planning**—H. E. Wessel, Virginia-Carolina Chemical Corp., 401 Main St., Richmond, Va. **Processing of Irradiated Fuels—A Challenge for the Future**—J. L. Schwennesen, A.E.C., P.O. Box 1221, Idaho Falls, Idaho. **Spray Mechanisms**—J. F. Tourtellotte, Swenson Evaporator Co., 18505 James Couzens Highway, Detroit, Mich. **Air-Cooled Heat Exchange**—W. W. Akers, Dept. of Chem. Eng., Rice Institute, Houston, Texas. **Education in Process Control**—T. J. Williams, Monsanto Chem. Co., 1700 S. Second St., St. Louis 4, Mo. **General Papers**—W. M. Licht, Dept. of Chem. Eng., Univ. of Cincinnati, Cinn., Ohio. **Education and Accreditation**—C. C. Monrad, Chem. Eng. Dept., Carnegie Inst., Pittsburgh 13, Pa.
Deadline for papers: August 7, 1958.

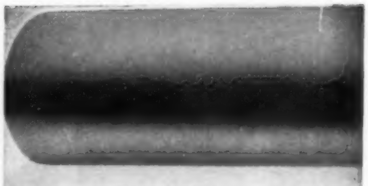
1958—NON-A.I.Ch.E.

• Geneva, Switzerland, Sept. 1-13, 1958. **Second International Conference on the Peaceful Uses of Atomic Energy.**

1959—MEETINGS—A.I.Ch.E.

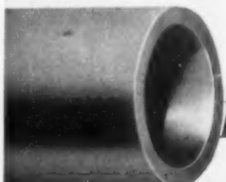
• Atlantic City, N. J., March 15-18, 1959. **A.I.Ch.E. National Meeting.** Chalfonte Haddon Hall Hotel. Gen. Chmn.: J. D. Stett, Dept. Mech. Eng., Rutgers Univ., New Brunswick, N. J. Tech. Prog. Chmn.: N. Morash, Natl. Lead Co., P.O. Box 58, So. Amboy, N. J. **Recent Advances in Plastic Materials of Construction**—M. F. Gigliotti, Monsanto Chem. Co., Plastic Div., Springfield, Mass. **Business & Technology**—J. Happel, NYU, University Hgts., New York. N. Y. **Laboratory and Pilot Plant Techniques**—G. W. Blum, Goodyear Tire & Rubber Co., Akron, Ohio. **Rockets, Missiles & Satellites**—G. C. Szego, Gen. Elect., Aircraft & Gas Turbine Div., Cinn. 15, Ohio. **General Papers** (2 sessions), J. Joffe, Newark Coll. of Eng., 367 High St., Newark 2, N. J. and E. C. Johnson, Dept. of Chem. Eng., Princeton U., Princeton, N. J. **Computer Control of Processig Units**—J. M. Mozley, Johns Hopkins Hospital, Baltimore 5, Md. **Startup of New Chemical Plants**—M. L. Nadler, DuPont, Penns Grove, N. J. **Care and Feeding of Executives**—J. S. Wilson, Heidrick & Struggles, 20 No. Wacker Dr., Chicago 16, Ill. **Mechanics of Fluid-Particle Systems**—S. K. Friedlander, Columbia U., New York 27, N. Y. **Process Data & Design Methods for Nuclear Fuel Recovery**—C. E. Stevenson, Rsch. Dir., P.O. Box 1259, Idaho Falls, Idaho. **Thermodynamics of Phase Equilibria**—E. M. Amick Jr., Chem. Eng. Dept., Columbia U., New York 27, N. Y. **Market**

continued on page 124



kraloy plastic pipe

protects product



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Kraloy PVC Plastic Pipe used in your plant will deliver your product clean and pure. You particularly need Kraloy PVC (which cannot scale or corrode) if your product or any of its components react to metallic pipe and acquire impurities from it. Clean as glass, KRALOY PVC PIPE is proud to have been granted the approval of the National Sanitation Foundation.

Kraloy PVC High Impact Plastic Pipe and Tubing will deliver most liquid and gaseous chemicals with higher efficiency and less maintenance and policing than any other standard piping material. Superior flow characteristics (C factor=150+) eliminate problems concerned with fatty acids and other fats, oils, and syrups, and guarantee high flow rates with lower head loss. Ph factors from 2 to 13 are all the same to KRALOY PVC. Bends and other fabrications are easy. Abrasion? Send us your specifications, bearing in mind that KRALOY PVC PIPE is already used in many slurry installations. Instrument and instrument-control pipe and tubing, too.

Write for detailed brochure, and name of your factory representative nearest you.

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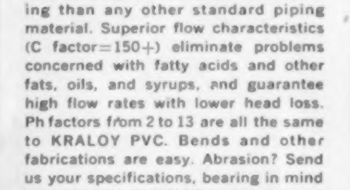

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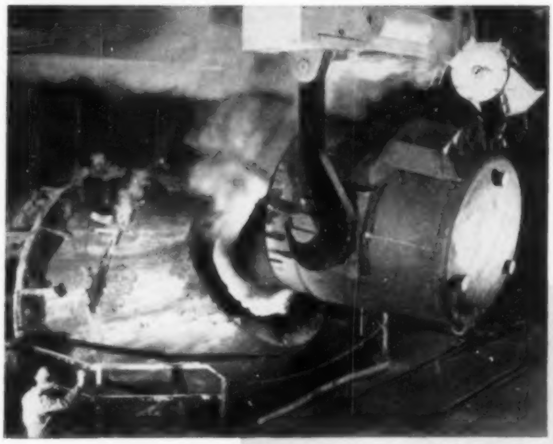
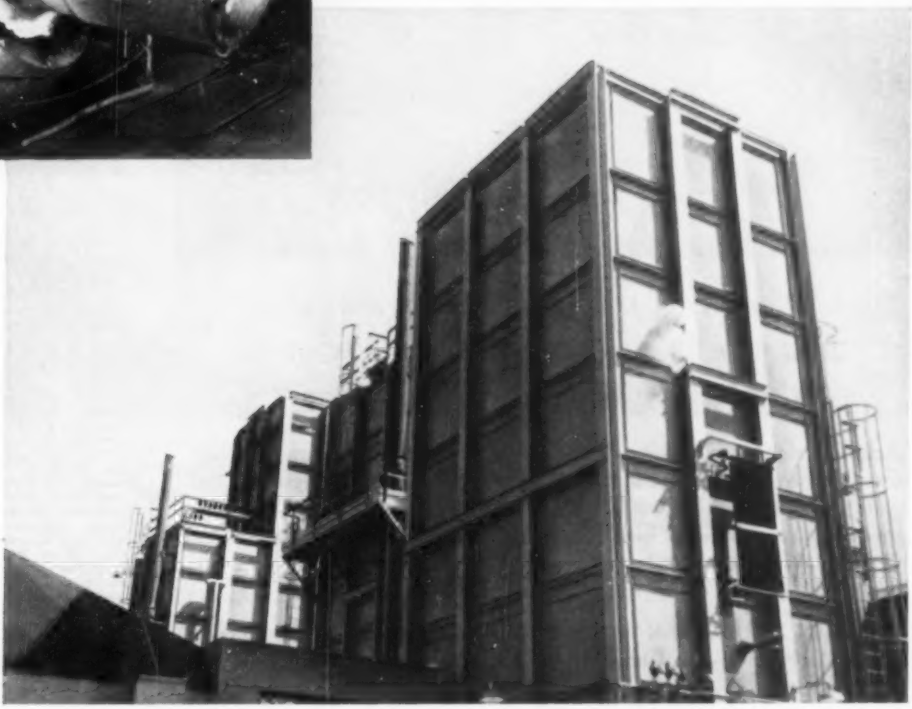
BIG THINGS are happening at Jones & Laughlin

New Basic Oxygen Furnaces at Jones & Laughlin's Aliquippa Works . . . the world's largest . . . wouldn't have been possible 10 years ago. The price of oxygen was too high.





Thanks to a technical break-through* in oxygen manufacturing by Air Products, Jones & Laughlin will have the lowest cost oxygen available even 10 years from now.

The new oxygen process is the result of Air Products' dedicated efforts through the years to improve oxygen supply at lowest cost. Because of this effective work, oxygen is now widely used rather than remaining the high priced specialty of a limited few.

Jones & Laughlin benefits now from low cost oxygen with maximum reliability of supply. An extra benefit is by-product, ultra-high purity nitrogen. Why not investigate this superior system for your needs today?

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TO MEET YOUR BULK WIRE CLOTH NEEDS, we have a wide variety of specifications from the finest to the coarsest mesh—in any metal or alloy—in the most frequently used specifications ready for immediate shipment. Individual loom operation and careful inspection just before shipment assures accurate mesh count and uniform mesh size.

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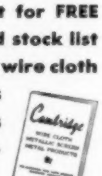

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OFFICES IN PRINCIPAL INDUSTRIAL CITIES

future meetings

from page 122

Research & the Chemical Engineer—William Copulski, Grace R&D Co., 3 Hanover Sq., New York 4, N. Y. **Thermal Stability of Jet and Rocket Fuels**—C. J. Marsel, NYU, Univ. Heights, New York, N. Y. **Theoretical & Laboratory Work on Liquid-liquid Extraction**—R. E. Treybal, Chem. Eng. Dept., NYU, University Hghts., New York 53, N.Y. Deadline for papers: November 16, 1958.

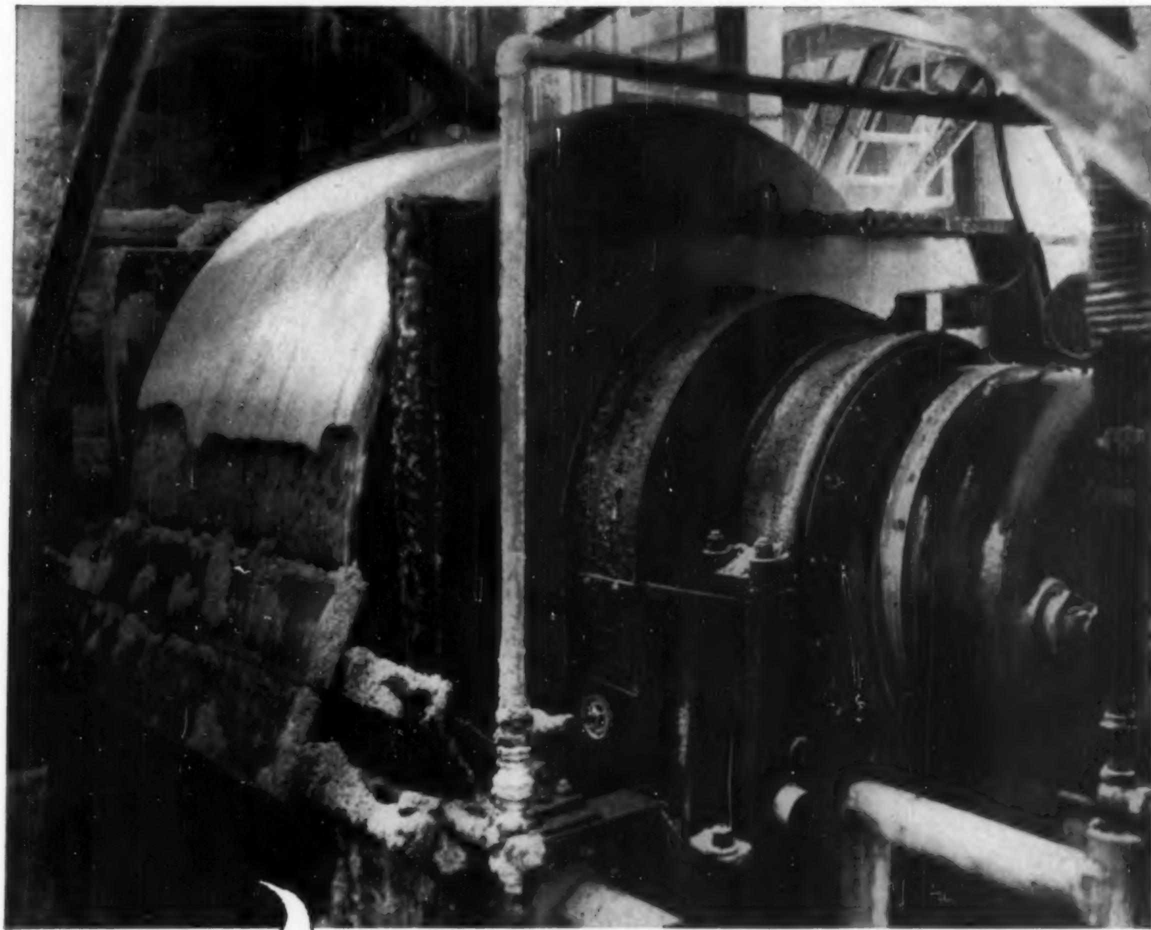
• Kansas City, Missouri, May 17-20, 1959. Hotel Muehlebach. **A.I.Ch.E. National Meeting.** Gen. Chmn.: F. C. Fowler, Consulting Chem. Engr. 7515 Troost Ave., Kansas City, Mo. Tech. Prog. Chmn.: Fred Kurata, Chem. Eng. Dept., Univ. of Kansas, Lawrence, Kansas. **Reaction Kinetics** — R. R. White, Dept. of Chem. Eng., Univ. of Michigan, Ann Arbor, Mich. **How to Become a More Proficient Technical Engineer. Heavy Chemicals**—N. J. Ehlers, Columbia-Southern Chem. Corp., 1 Gateway Center, Pitts. 22, Pa. **Petrochemicals**—G. E. Montes, Natl. Petrochemical Corp., Tuscola, Ill. **International Licensing and Collaboration**—R. Landau, Scientific Design Co., 2 Park Ave., New York, N. Y. **General Papers** (2 sessions), J. O. Maloney, Univ. of Kansas, Lawrence, Kan. and Merk Hobson, Univ. of Nebraska, Lincoln, Nebr. **Non-Equilibrium Fluid Mechanics**—M. J. Rzasa, Cities Service Res. Lab., P. O. Box 402, Cranbury, N. J. **Multiphase Flow in Pipes and Annuli**—C. S. Kuhn, Magnolia Petroleum Co., 907 Thomasson Dr., Dallas, Tex. **Thermodynamics of Jet & Rocket Propulsion**—G. C. Szego, Gen. Elect. Aircraft & Gas Turbine Div., Cinn. 15, Ohio. **Computers and Pipelines**—R. L. McIntire, The Datics Corp., 600 Camp Bowie Blvd., Fort Worth, Texas.
Deadline for papers: January 17, 1959.

• St. Paul, Minn., Sept. 27-30, 1959. Hotel St. Paul. **A.I.Ch.E. National Meeting.** Gen. Chmn.: W. M. Podas, Asst. Rsch. Dir., Economics Lab., Guardian Bldg., St. Paul, Minn. Tech. Prog. Chmn.: A. J. Madden, Jr., Univ. of Minn. **Mixing**—J. Y. Oldshue, Mixing Equip. Co., Inc., P. O. Box 1370, Rochester 3, N. Y. **Size Reduction**—E. L. Piret, Chem. Eng. Dept., Univ. of Minnesota, Minneapolis 14, Minn.

• San Francisco, Calif., December 6-10, 1959. **A.I.Ch.E. Annual Meeting.** Gen. Chmn.: Mott Souders, Jr., Shell Development Co., 4560 Horton St., Emeryville 8, Calif. Tech. Prog. Chmn.: C. R. Wilke, Div. of Chem. Eng., Univ. of Calif., Berkeley, Calif. **Process Dynamics**—E. F. Johnson, Dept. of Chem. Eng., Princeton Univ., N. J. **Secondary Oil Recovery Methods; New Oil Sources—Shale, Gilsonite, Tar Sands; Financing in the Chemical Industry; Raw Materials for the Chemical Industry; Turbulence and Turbulent Mixing; High Temperature: Thermodynamics, Reactions, Kinetics; Devices, and Materials-Operations Research; Electro-chemical Engineering-Process Design; Fundamental Aspects of Chemical Engineering in the Pulp and Paper Industry.**
Deadline for papers: August 6, 1959.

A new methanol plant is now on stream near Pensacola, Fla., for Escambia Chemical Corp. The plant, which has a design capacity of 16 million gallons a year, is the first methanol plant in the Southeast. #

Predictions as to what colors will be popular with consumers six to 12 months in the future, are being added to the services Du Pont extends to the designers and manufacturers of plastic products. The new service, made available through a recent agreement between Du Pont's Polychemicals Dept. and color consultant Faber Birren, is based on research into the long-term patterns of public acceptance or rejection of colors. The service is expected to enable Du Pont customers to improve sales appeal.



Soda Ash

from California's desert lakes

Fifty miles southwest of Death Valley, California, West End Chemical Company, a Division of Stauffer Chemical, is recovering sodium carbonate crystals from the brines of Searles Lake (an underground lake in the desert). The raw brines from this lake are carbonated to precipitate $NaHCO_3$, which is classified and thickened in Dorr Classifiers to 25-30% solids prior to dewatering by the Oliver Salt Type Filter shown above. This 6′ dia. by 6′ face Oliver Filter is one of three identical stainless steel units in use on this product. (Note the high capacity 28″ dia. valve on the right hand side of the photograph.)

The sodium carbonate is then calcined to soda ash, a basic chemical used in the manufacture of soaps, glass, and many other consumer products.

This recovery process is unique, as the spent liquor remaining after processing is returned to the lake. Thus, the laws of nature provide a continuous closed circuit processing operation.

If you have a problem involving liquid-solids separation, Oliver Filters should rate as your number one consideration. Complete information on Rotary Drum Filters for the processing industries may be obtained by writing Dorr-Oliver Incorporated for a copy of Bulletin No. 7200.

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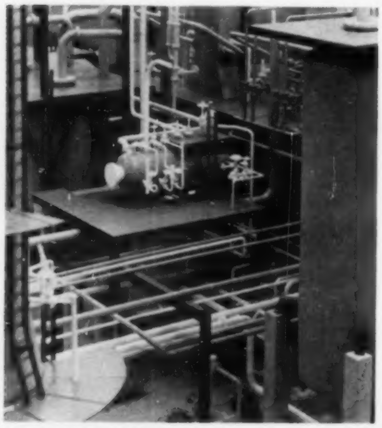
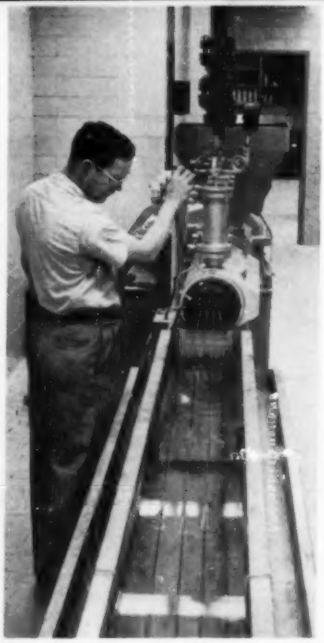
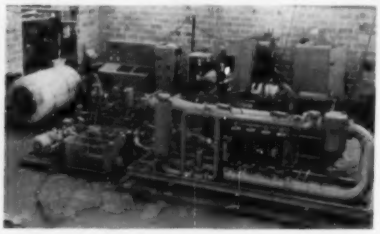


Brussels World's Fair displays this M. W. Kellogg model of catalytic reformer as example of U. S. type of equipment and refinery design. Shown in U. S. Pavilion.

Montreal recently was site of major chemical engineering conclave, with (top to bottom) Habitant square-dancing, Lester Pearson addressing luncheon (with A.I.Ch.E. President Holbrook), and Russian delegates (one left and two extreme right). General chairman Lyle Streight is second, and interpreter —chemical technologist J. G. Tolpin, third from left.



$5 Million pigment sales service lab recently opened by Du Pont at Chestnut Run, Del., is equipped with this plastics extruder. Plastics industry is big user of pigments.



Bomarc ram jet missile engine test stand, to check various components of fuel, hydraulic, electric and other operational systems. Made by Greer Hydraulics, Inc.

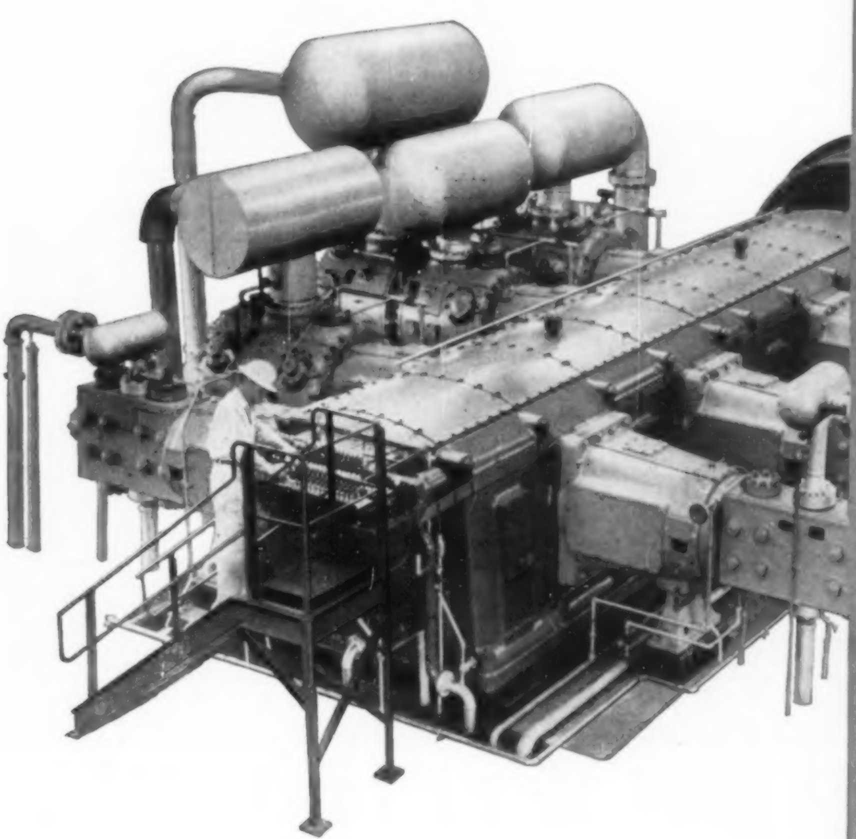
Engineering Center Greater N. Y. Business Campaign officials, left to right, John J. Theobold, Deputy Mayor; Commissioner R. C. Patterson, Dept. of Commerce and Public Events of N. Y. C.; William H. Byrne, Chairman of the Greater New York Business Campaign; Mayor Wagner; Abe Stark, President of the City Council of N.Y.C.; and C. F. Preusse, City Administrator.

Technical center recently dedicated by Atlas Powder broadens the company's product development, technical service activities. Chemical engineering facilities (elsewhere) benefit through taking over space previously used by new occupants.

New Founder is admitted to the United Engineering Trustees, Inc. in ceremony May 1st. A.I.Ch.E.'s induction shows (seated left to right at table): David W. R. Morgan, Past President, ASME, representing James N. Landis, President, ASME; Augustus B. Kinzel, President, AIME; Walter J. Barrett, President, AIEE and also President, UET; George E. Holbrook, President, A.I.Ch.E.; and Louis R. Howson, President, ASCE. Standing, Secretaries: O. B. Schier II, ASME; Ernest O. Kirkendall, AIME; Steven W. Marras, UET; F. J. Van Antwerpen, A.I.Ch.E.; and William H. Wisely, ASCE.

America's most powerful compressor

THE 10,000 HP COOPER-BESSEMER LM



Proved by thousands of operational hours

the basic LM design offers you the very latest in design and engineering development. The nearest Cooper-Bessemer office will gladly furnish complete information.

THE LM COMPRESSOR OFFERS YOU THESE TEN IMPORTANT ADVANTAGES:

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- greatest power-to-space ratio
- low installation cost
- minimum maintenance requirements
- main frame of high strength Meehanite Metal
- rod load rating, 125,000 psi
- pistons can be removed without disturbing compressor piping
- extreme accessibility
- greatest availability for multi-stage, multi-service requirements

Designed for the continuous compressing of large volume gas or air . . . in petrochemical, chemical, refinery and industrial operations . . . this 10,000 hp Cooper-Bessemer LM compressor not only delivers efficiency, economy and availability, but occupies no more space than other units of half the horsepower.

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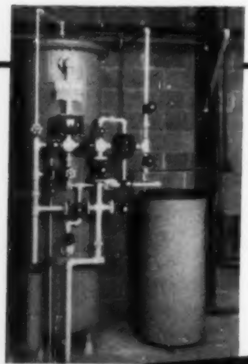

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It removes all ionizable impurities . . . including CO_2 and silica.

Low investment and operating cost.

Requires less space . . . thanks to exclusive "double-check" design.

ELGIN WATER CONDITIONING SINCE 1908 — 50th Anniversary 1958

Zeolite Water Softeners
Dealkalizers
Deaerating Heaters
Filters of all types
Water Conditioning Products for every need.

Write for Bulletin 512

ELGIN SOFTENER CORPORATION
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A. I. Ch. E. candidates

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before July 15, 1958, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

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Antolak, John P., *Chicago, Ill.*
Bianco, Joseph H., *Pittsburgh, Pa.*
Bowman, E. D., Jr., *Denver, Colo.*
Brown, Judson G., *Wakefield, Mass.*
Burton, Conway C., *Chicago, Ill.*
Burzlaff, Arthur A., *Waterloo, Iowa*
Chisholm, Douglas S., *Midland, Mich.*
Choppin, A. R., *Baton Rouge, La.*
Cochran, D. E., *Rosenberg, Texas*
Cullen, John D., *Orange, Texas*
Donohoe, Howard V., *Niagara Falls, N. Y.*
Ensminger, Stanley W., *White Plains, N. Y.*
Fessenden, L. Daniel, *Brockport, N. Y.*
Gardner, Frank H., Jr., *Hattiesburg, Miss.*
George, David M., *Mc Gregor, Texas*
Groh, Alan B., *Whiting, Ind.*
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Hoffmann, James M., *Wilmington, Del.*
Hurt, Nathan H., Jr., *Akron, Ohio*
Koenig, James J., *East St. Louis, Ill.*
Kuhn, William A., *Kirkwood, Mo.*
Levy, Louis M., *Cincinnati, Ohio*
McChrystal, Richard G., *Los Angeles, Calif.*
Oman, Clifford E., *Tuscola, Ill.*
Reeve, Ralph T., *North Branch, N. J.*
Rinehart, E. W., *Richmond, Calif.*
Rolston, J. A., *Charlottesville, Va.*
Roszkowski, Edmund S., *Colonia, N. J.*
Rozzi, Marcellus C., *Colonia, N. J.*
Scott, H. Andrew, *Kingsport, Tenn.*
Shelburne, Victor B., *Lewiston, N. Y.*
Slifer, Robert L., *Kirkwood, Mo.*
Smalling, Jack W., *Baytown, Texas*
Sullivan, Eugene F., *El Cerrito, Calif.*
Welch, Donald H., *Lake Charles, La.*

ASSOCIATE

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Armstrong, William S., *Midland, Mich.*
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Baker, M. H., *Minneapolis, Minn.*
Bowersock, Robert V., *Richland, Wash.*
Brazelton, Hallet, *Decatur, Ala.*
Brodsky, Robert, *New York, N. Y.*
Brown, Elmo C., *Baton Rouge, La.*
Christianson, Charles R., *Kalamazoo, Mich.*
Cohen, Herbert, *Cleveland, Ohio*
Cohen, William C., *Philadelphia, Pa.*
Collins, E. Denson, *Port Arthur, Texas*
Collins, M. Thomas, *Arsenal, Ark.*
Colton, Ralph F., *Chicago, Ill.*
Cornwall, Richard H., *Wilmington, Del.*
Cosway, Harry Francis, *Toledo, Ohio*
Crow, Wesley M., *Houston, Texas*
Dunn, Roy B., *Arsenal, Ark.*
Durante, Albert W., *Newark, Del.*
Evans, James M., *Library, Pa.*
Fields, Marvin C., *Pittsburgh, Pa.*
Finelt, Stanley, *Houston, Texas*
Fischer, Morgan, *New York, N. Y.*
Franz, William F., *Beacon, N. Y.*
Fritsch, John J., Jr., *Corpus Christi, Texas*
Gelbein, Abraham P., *New York, N. Y.*
Gough, James A., *Honolulu, Hawaii*
Gygi, Edwin H., *Longview, Wash.*
Habib, Austin G., *Linden, N. J.*
Hopkins, Perry A., *Highland, Ind.*
Hwa, Chih Shing, *Roselle, N. J.*
Lait, Robert I., *Swampscott, Mass.*
Lakemeyer, James L., *Clayton, Mo.*
Le Croy, Clarence R., Jr., *Savannah, Ga.*
Leng, Douglas E., *Midland, Mich.*
Marshall, John J., *Westwood, N. J.*
McIntyre, G. H., Jr., *Monterey Park, Calif.*
Meinert, Richard N., Jr., *Huntsville, Ala.*
Mills, Arthur K., *Midland, Mich.*
Mosel, Joseph E., *Louisville, Ky.*
Mueller, George L. Jr., *Channelview, Texas*
Naustdal, Are, *Southport, Conn.*
Nickelson, Robert L., *Bozeman, Montana*

continued on page 138

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pH, CHLORINE, PHOSPHATE

TESTS

to insure precise control

Taylor Comparators allow you to make fast, accurate colorimetric tests for pH, chlorine, phosphate or nitrates, etc. right on the spot. In a matter of minutes you get correct operational data to help you determine the exact amounts of chemicals needed to properly control crystallization, bleaching, precipitation, extraction or waste treatment. To use, simply fill the middle tube with treated sample, move color standard slide across until sample matches one of the standards. Values are then read directly from the slide.

Taylor Comparators are durable, lightweight, portable. Many serve for several determinations with only a change of color standard slides.

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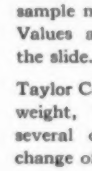
Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results. All Taylor liquid color standards carry an unlimited guarantee against fading.



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A Ljungstrom® air preheater can cut 20% off your fuel bill by getting more heat from your fuel. That means you burn less of your regular fuel to get the same operating temperature, or you can switch to cheaper fuels without affecting product quality. Either way, every barrel of output can cost 20% less in fuel.

A Ljungstrom air preheater gets more productive heat from any fuel by boosting the temperature of the combustion air — sometimes as much as 1000F. Fuel burns more completely in preheated combustion air, and leaves less slag and deposit behind, so the fuel-burning equipment stays efficient longer.

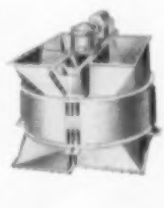
How fast is "WRITE OFF"?

What you save on fuel can pay for the Ljungstrom in two years. If you take advantage of the extra capacity of a Ljungstrom-equipped system to increase output or to improve product quality, the Ljungstrom can pay for itself within nine months.

Write today for your copy of a factual article by Mr. O. F. Campbell of Sinclair Refining Company, describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

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STRIKES!


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- The Model M-1 Detector is a *low voltage* electrical inspection instrument consisting of a cellulose sponge electrode on a plastic wand handle connected to a dry-cell battery operated detector unit hung from the inspector's belt. The unit weighs 4 pounds. When the sponge is dampened with water and is wiped over a painted surface the most minute pin-hole can be found and a *bell* on the detector will ring. Write today for data sheets . . . Sent gladly.

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H. R. L. Streight—(left), principal chemical engineer, Engineering Department, Du Pont of Canada, has been awarded the Plummer Medal of the Engineering Institute of Canada for his paper on air control measures at Du Pont's Maitland Works, delivered before the Institute's annual meeting at Banff, Alberta, last June. Streight is a former director of the Chemical Institute of Canada; past chairman, chemical engineering subject division, C.I.C.; and a member of the editorial board of the new technical journal, "Canadian Journal of Chemical Engineering." He was conference chairman of the recent combined meeting in Montreal of the A.I.Ch.E. and the Chemical Institute of Canada.

New staff members at Proctor & Gamble include: **Robert L. Morris,** who joins the Exploratory Development Division; **William C. Moger,** who joins the Development Department of the Overseas Division; and **Alexander L. Liepa,** who becomes a member of the Development Department of the Foods Division.

Food Machinery and Chemical Corp. has named new managers of four of its operating divisions. They are: **Robert J. Delargey**—Westvaco Chlor-Alkali Division; **Raymond F. Moran**—Westvaco Mineral Products Division; **Dewey H. Nelson**—Becco Chemical Division; and **Stuart H. Bear**—Niagara Chemical Division.

continued on page 132

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Check these advantages:

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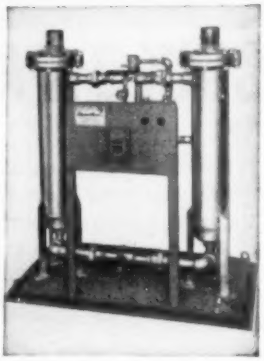

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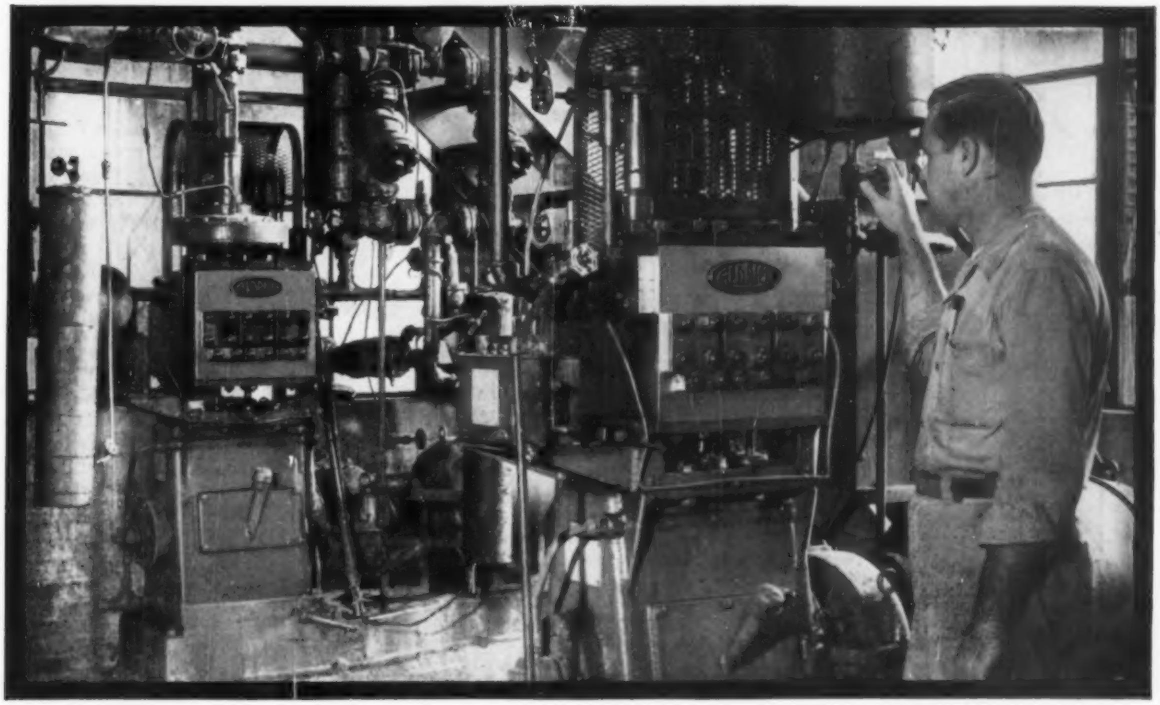
EMERY INDUSTRIES LICKS TOUGH PROBLEM:

How to pump fatty acids 24 hours a day, 7 days a week, and cut maintenance costs!

Around-the-clock hydrolysis produces fatty acids from animal fats, tallow, palm, soybean, cottonseed and corn oils at Emery Industries plant in Cincinnati, Ohio. Pumps work on hot corrosive fatty materials 24 hours a day, seven days a week, and maintenance used to be a costly problem. Packings had to be replaced far too often. Valves needed frequent refacing. Wear of plungers was excessive.

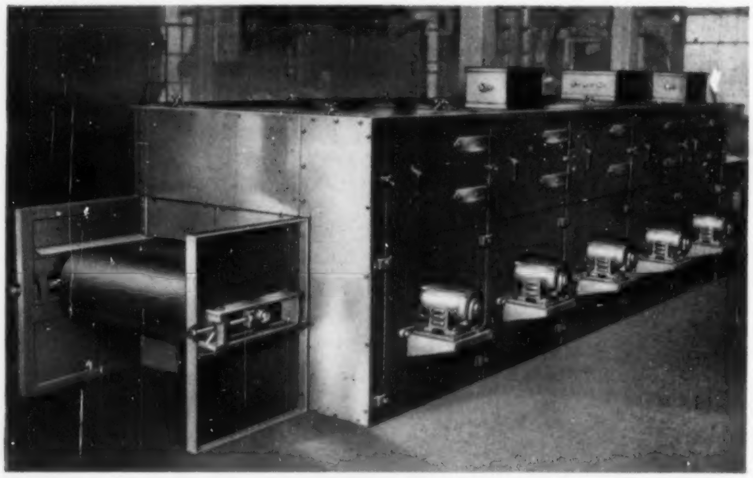


How Emery solved the puzzle: Looking for an answer to the problem of excessive downtime and maintenance, Emery conferred with several pump manufacturers. Aldrich was the only company to offer a pump better in both design and materials . . . the fluid end being of stainless steel. Original, ineffective pumps were immediately replaced with Aldrich Triplex Pumps.

Result: Two Aldrich Pumps have pumped raw materials on a continuous basis since 1948. Two more were installed for additional capacity in 1954. Maintenance costs have been reduced substantially. Downtime has decreased to a minimum. Operating efficiency is now at an all-time high and quality of processing has improved. We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 20 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

THE FLEXIBILITY OF A LAB DRYER
THE DEPENDABILITY OF A PRODUCTION DRYER



SARGENT'S NEW PILOT PLANT DRYER

Each drying section, or any arrangement of groups of sections, can be zoned and controlled independently to provide widest possible variation of temperature, humidity, etc., where needed. Production technique and settings are determined accurately, transferred to the production dryers without need for adjustment. Additional sections are added easily and quickly at your plant. They are delivered as a complete unit with motor, fan, heating coils and conveyor in place. Compact, made in two sizes, the smaller being only 4'-0" high and 3'-9" wide. Uses gas, electricity or steam for heating element. Simple adjustment to regulate conveyor speed. Fully instrumented, has all necessary controls and recording charts. It's a little giant of versatility — invaluable in the modern, cost-conscious pilot plant. Let us give you details.

FOR:

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- CARBON BLACK
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- PIGMENTS
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- LATEX
- PHARMACEUTICALS
- PLASTICS
- SODA LIME
- SENSITIVE OR UNSTABLE MATERIALS

FOR ALL THE PROCESS INDUSTRIES

Sargent Dryers for Lab, Pilot Plant, Production (Conveyor, Tray, Tunnel, Truck) — easiest, speediest to install . . . less time than any other dryer on the market. Also Sargent Feeds, Automatic, Mixing, Weighing feeds . . . Extruders . . . Granulators . . . Coolers . . Special Processing Machinery.

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from page 130

Robert E. Wilson, retired chairman of Standard Oil Co. (Indiana), has been retained by Continental Can Co. to make a comprehensive study of the organization and scope of the company's extensive research and development work.

Paul D. V. Manning, who retires on June 30 of this year from his position as senior technical vice-president of International Minerals & Chemical Corp., has been appointed professor of chemical engineering at California Institute of Technology. Manning joined International Minerals and Chemical in 1941 as director of research.

Barrett Division, Allied Chemical & Dye, has announced appointment of **Maurice H. Bigelow** as vice-president of the division. Formerly technical director, Bigelow will continue as head of Barrett's Research and Development Department.

Newly-appointed chairman of the Army Scientific Advisory Panel is **Richard S. Morse** (left), president of National Research Corp. As chairman of the Panel, Morse succeeds **Frederick L. Hovde,** president of Purdue University.

Howard M. Rodekohr has joined the process design section of Ethyl Corporation's Research and Development department at Baton Rouge, La.

Heyden Newport Chemical Corp. has named **Herman Sokol** as executive vice-president. Since 1954, Sokol has been vice-president in charge of all Heyden research and development.

T. Q. Eliot has been appointed head of the Process Technical Service Department at Texas Butadiene & Chemical. Eliot will be responsible for process activities and economic evaluation of the company's new butadiene and aviation gasoline plant at Channelview.

continued on page 134

LEHMANN VORTI-SIV

multiple whirlpools screen materials previously un-screenable

The Vorti-Siv successfully screens powders, liquids and slurries in meshes from 4 to 400. Mesh sizes are changed quickly and easily. It has made practicable the screening of materials that heretofore were regarded as un-screenable on a commercial basis.

The whirlpool action, variable in both speed and size, is what sets the Vorti-Siv apart from conventional screening machines . . . allows greater throughputs with fine mesh screens.

For complete information and prices, contact an authorized Vorti-Siv Agent or:

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New York, New York

Ill. (Southern) Mo.
Harry A. Baumstark & Co.
6801 Arsenal Street
St. Louis, Missouri

Ill. (Northern) Wis.
Webster Equipment Co.
549 W. Randolph Street
Chicago, Illinois

Fla. S.C. N. C Ga. Tenn.
The Hoshall Company
1414 Morningside Drive
Atlanta, Georgia

Mich.
Harry Holland & Son, Inc.
10600 Puritan Avenue
Detroit 38, Michigan

Calif.
The Moore Drydock Co.
Ft. of Adeline Street
Oakland, California

Mexico
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Apartado 911
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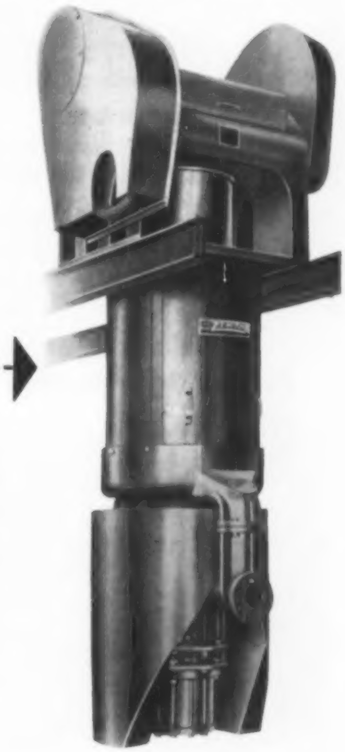

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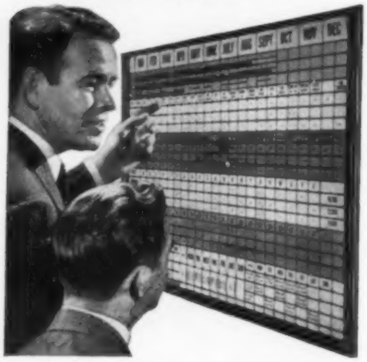

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from page 132

Henry H. Shepherd has been named vice-president in charge of sales for the Bird Machine Co., South Walpole, Mass. Shepherd, who has been with Bird for over twenty years, was general sales manager prior to his election as vice-president.

W. Allen Taft, formerly director of sales of Du Pont's Photo Products Department, has been named director of sales of the company's Petroleum Chemicals Division. He succeeds **W. Samuel Carpenter, III,** who was recently appointed assistant general manager of the Electrochemicals Department.

Donald L. McCuen has joined the Industrial Chemicals Division of Pittsburgh Coke & Chemical Co. as a sales representative. Prior to joining Pittsburgh Coke & Chemical, McCuen was technical representative, Polymer Chemicals Division, of W. R. Grace & Co.

Frank W. Crowe has joined the sales engineering staff of the engineering and construction division of Southwestern Engineering Co.

The Process Sales Company, under the management of **L. P. Skinner, Jr.,** will represent the Kinetrol Co. Dallas, Texas, in Southern Texas and Southwestern Louisiana. Prior to forming the new company, Skinner was with Du Pont's Savannah River plant (AEC) as instrument group leader.

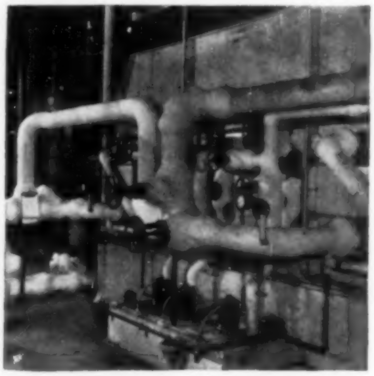
Necrology

Joseph J. Schaefer, 59, chemical consultant, New York, N.Y.

O. R. Sweeney, 76, formerly head of the Chemical Engineering Department, Iowa State College. Sweeney was a pioneer in the development of methods for the industrial utilization of agricultural waste products and of processes in the water softening field.

George V. Slottman, 54, vice-president, research and engineering, Air Reduction Co.

...a machine with "A GOOD RECORD as a REVENUE PRODUCER"



A typical case of using a Niagara Aero Heat Exchanger to provide cooling for production equipment shows amortization of this machine in 16 months and $90 per day revenue thereafter.

Industrial engineers with careful cost, upkeep and revenue records on all machines, credit Niagara Aero Heat Exchangers with important gains over other methods.

They use these machines to provide cooling for production equipment, welders, extruders, drawing dies, furnaces, quench baths, plating, chemical and electronic process...all millwater system uses.

They get positive control of critical process temperatures with improved product quality, rejection losses prevented. Heat is removed at the rate of in-put.

A closed system, dirt free prevents all troubles from bad water; transferring heat to the atmosphere by the evaporation of a very small amount of water solves all problems of water supply or disposal.

Write for Bulletins 120, 135

NIAGARA BLOWER COMPANY
Dept. EP-6, 405 Lexington Ave., New York 17, N.Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

"...AND QUIETLY BOLD"

A Message to the Scientific Community from Dr. Hugh L. Dryden, Director, NACA

NACA has pioneered in preparations for manned and unmanned space flight for the past six years and has designed and built unique aerodynamic, structural and propulsion facilities for space research. We of NACA are moving to insure that our contributions to space technology will match our record in aeronautics. It is imperative that America lead the way in the peaceful exploration of space. Our nation has the talents and resources to do the job. But we must recall the wisdom of the Killian Committee which recently said: "Let us be cautious and modest in our predictions and pronouncements about future space activities and quietly bold in our execution."

Hugh L. Dryden

Hugh L. Dryden

Hugh L. Dryden, Director, NACA; Ph.D., Johns Hopkins University

NACA has a staff of 7,750 research scientists and supporting personnel spread among its research centers on both Coasts and in Ohio. NACA staff members in pursuit of new knowledge have available the finest research facilities in the world, including several of the largest and fastest supersonic and hypersonic wind tunnels, hot jets, a fleet of full scale research airplanes, which will include the X-15, hypersonic ballistic ranges, shock tubes, a nuclear reactor establishment, rocket facilities, a research missile launching site, tracking devices, and the most advanced mechanical and electronic computers.

NACA Fields of Research Include: Analytical Dynamics, Solid State Physics, Hypersonic Aerodynamics, Magneto Hydrodynamics, Energy Sources, Propulsion Systems, Aerodynamics, Automatic Stabilization, Vehicle Configuration and Structure, Materials, Flight Simulation, Instrumentation.

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Langley Aeronautical Laboratory, Hampton, Virginia
Ames Aeronautical Laboratory, Mountain View, California
Lewis Flight Propulsion Laboratory, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

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This is an exceptional opportunity for a young chemical engineer, Ph D or Sc D, age approximately 30-35 yrs, with interest in development of chemical processes and engineering design data in small-scale equipment.

Must have outstanding academic record and successful professional experience in chemical research and development, and must be completely up-to-date on modern research strategies and chemical engineering unit operations. Location East Coast. Send complete resume to:

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This work is a part of a product-service group within an engineering department. You should have a keen interest in applying apparatus to the needs of the oilfied lease operator. You will be a link between the salesmen and the engineering group. Technical writing is a part of the work. For this job, we believe you should have 2 years or more experience with oil-country equipment as a gas engineer or production engineer. Some of this might well have been in sales work.

If this opening interests you, please send us a resume of your experience. We will reply promptly and your application will be held in confidence. Salaries for these positions are open and will depend upon your experience and ability. Address your reply to The Parkersburg Rig & Reel Company, Box 12007, Forth Worth, Texas.

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New Science Department, community intensely interested in developing strong science department because of mining and chemical processing industries. Salary if B.A. + 24 and 5 years' teaching experience, $6100: if M.A., $6500. Write Superintendent, Trona Unified School District, Trona, California, for complete information.

MANUFACTURERS AGENTS—Midwest manufacturer with 30 years' experience producing chemical process equipment including ventilation, fans, scrubbers, and heat transfer equipment. Desire additional representation in Michigan, Texas, Louisiana, Carolinas, Georgia, and Kansas areas. Give full particulars. Box 3-6.

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CHEMICAL ENGINEER—B.S. Ch. E. 1953. Five years' experience in process development and production. Actively engaged in the development of several new processes, now in the plant status. Seeking responsible position in process development. Will consider only companies in vicinity of Boston, Mass. Box 5-6.

CHEMICAL ENGINEER—Rocket experience—eight years R & D propellants, propulsion, ordnance.—broad background design analysis, thermodynamics, high energy systems, materials, processes. Publications, patents, B. Ch. E. Advanced graduate courses, M.E. Age 33. Desire challenging opportunity in propellants and rocketry. Eastern location. Box 6-6

CHEMICAL METALLURICAL ENGINEER — M.S. Extensive specialized education in metallurgy, chemistry, chemical engineering. Experience in consummable electrode melting and metallurgy of reactive metals molten salt reactions, corrosion, electrochemistry, high temperature reactions and thermodynamics, citizen, cleared, 34, single. Box 7-6.

CHEMICAL ENGINEER—B.S., veteran, age 38, family. Nine years' production, technological, and pilot plant experience in petrochemicals. Process evaluation. Catalysis. Resume available. Desire responsible technological or production position in Houston area. Box 8-6.

CHEMICAL ENGINEER — B.Ch.E. Age 26, married, military service completed. Experience in process design, piping and equipment layout. Seeking position with opportunity in development or technical service. Box 9-6.

CHEMICAL ENGINEER—Age 32, eleven years' broad and diversified experience. Process and project engineering coal, coke, chemical, carbon specialties; chemical plant design, economics, sales and operation, solvent extraction and fats and oils. Engineer contractor closing office. Desire sales and engineering position. Chicago area. Box 10-6.

CHEMICAL ENGINEER—B.S., M.S. Ch. E. Six and one-half years experience in Research and Development. Includes plant experience and cost estimation. Age 33. Willing to relocate. Interested in production, development, process work. Married, three children. Box 11-6.

CHEMICAL ENGINEER—Four years' varied pilot plant experience. Sound technologist with current BA training. Desire more rapid advancement. Company size or location immaterial. Minimum salary $7800. Box 12-6.

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Ph d or M.S. in chemical engineering, demonstrated competence in applied process analysis and process mathematics. We are seeking top men to join central staff of large, diversified chemical company. Location New York. To work with established group of mathematicians, computer specialists, control engineers, and statisticians. Long range company-wide program is under way to improve operations and control methods of existing processes; to develop mathematical models and fundamental data for optimum design of new processes and equipment.

We also have an opening for a process improvement engineer to become staff member of new fiber plant in Florida. This man to transfer to Pensacola, Florida after a nine month training period with our central staff. Box #1-6

CHEMICAL-NUCLEAR ENGINEER—Five years' development experience with high temperature water, molten salt, and liquid metal reactor systems. "Q" cleared. B. Ch. E. plus graduate work in math., physics, business administration, engineering, and ready to learn more. Age 30. Seek group leader position. Box 13-6.

MANAGEMENT ENGINEER—B.Ch.E. plus other Engineering and Business Courses. Seventeen years' experience in development, production and management in a variety of industries. Registered. Age 39. Present salary $10,420. Now living North. Born and reared in South. Desire relocation there. Box 14-6.

CHEMICAL ENGINEER — Age 36, B.S.Ch.E. 1948, Phi Lambda Upsilon. Ten year's experience in the petro-chemical industry. Experience includes laboratory work, process engineering, production and economic evaluations. Desire challenging and responsible position in West United States. Box 15-6.

SENIOR PROJECT MANAGER—Plan now to put those developing research items into production. Evaluate from realistic economic studies; avoid "crash" programs. Twenty years' experience as Project Manager. Minimum salary $15,000. Will relocate. Box 16-6.

CHEMICAL ENGINEER — Production plant management, supervision and pilot plant development experience. Record of substantial cost reductions and profit improvements. Self starter with a shirt sleeve approach when necessary for leadership. Publications. Family. Fifteen years' substantial experience in the petroleum and petro-chemical industry. Desire connection with a reasonable opportunity for advancement in either production or production supporting activity. Box 17-6.

PRODUCTION MANAGEMENT ENGINEERING —Age 40. M.Ch.E. Fifteen years' experience in chemical food processing and aerosol packaging plants. Plant manager, process engineer, process evaluation and development, production supervision, seeking responsible position in production management. Present salary $11,000. Box 18-6.

CHEMICAL ENGINEER—B.S., graduate credits. Seven years' varied experience in petroleum and chemical process design, project engineering, and construction. Proven technical and management ability. Desire responsible position in medium or small chemical company. Eastern or Midwestern U.S. Box 20-6.

PRODUCTION MANAGEMENT ENGINEERING —M.E. Licensed. Thirty years diversified experience in heavy chemicals, design, construction and operation. Have been chief engineer two major chemical companies and plant manager. Seeking responsible position in production management. Box 21-6.

CHEMICAL ENGINEER—B.S. M.I.T. 1952. Four years' experience in pilot plant supervision, process development and research. Studying for M.B.A. Desire responsible position with progressive company. Married, two children. Box 22-6.

CHEMICAL ENGINEER — B.S.Ch.E. Age 37. Desire position as engineering supervisor or specialist. Experience in polymer field includes development, economics. Five years as molding compound production supervisor, process design and startup of large resin facilities. Present salary $10,000. Box 23-6.

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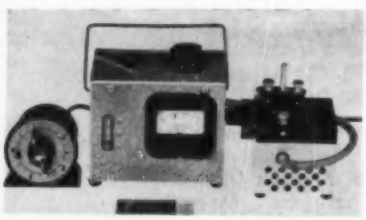

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Jesse Coates (left) and **Troy H. Middleton** (right) were inadvertently misidentified on p. 242 of the May issue of *CEP*.

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from page 128

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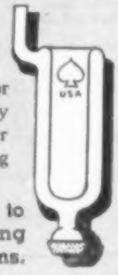

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news and notes of A.I.Ch.E.

United Engineering Center — Our Member Campaign to help raise the $300,000 that is A.I.Ch.E.'s quota for the new United Engineering Center will be initiated this month at the Golden Jubilee meeting . . . where representatives from Local Sections will hear our campaign chairmen, W. G. Whitman & S. D. Kirkpatrick, explain how A.I.Ch.E. hopes to raise the money. As the newest founder member of United Engineering Trustees, we are especially eager to make a good showing.

United Engineering Center, located as it will be across from the United Nations, has great significance, not only as a symbol of unity for the engineering societies, but also as an important center for international cooperation. When you are faced with the problem of giving, consider not only the present, but what is to come. Visualize the important part that engineering societies will play in the next fifty years. The future begins with engineering.

Special Representatives appointed by Council are a good indication of the number of projects on which your society is represented. . . . P. H. Groggins, Washington consultant and one-time Council member, attended three separate functions recently for A.I.Ch.E.: the inauguration of William Joseph McDonald as rector of Catholic University, the President's Conference on Occupational Safety, and the annual meeting of the Joseph A. Holmes Safety Association; D. O. Myatt attended the National Science Foundation one-day conference on Research and Development and Its Impact on the Economy, also in Washington; Roy G. Hemminghaus attended the inauguration of Frank Anthony Rose as President of the University of Alabama; A. N. Hixson attended the inauguration of Ernst Weber as President of Polytechnic Institute of Brooklyn; T. P. Forbath is the Institute representative to a planning committee considering the sponsorship of a Joint Societies Engineering Management Conference; and C. W. Nofsinger attended the Centennial of Iowa State College—all were representatives not only of A.I.Ch.E. but of the Chemical Engineering profession.

New Sections of A.I.Ch.E. have been formed. . . . Peninsular Florida and Southwest Louisiana, & the first subsection was established. . . . Brazosport Area Subsection of the South Texas Section of A.I.Ch.E.

Heat Transfer Division—The second division of A.I.Ch.E. came into being when Council at its meeting in Montreal approved the formation of the Heat Transfer Division, which now joins the Nuclear Engineering Division. . . . Officers of the Heat Transfer Division are A. C. Mueller, Chairman, & R. F. Fremed, Secretary-Treasurer. Already slated is the Second National Heat Transfer Conference held jointly with A.S.M.E. from August 18 to 20 at Edgewater Beach Hotel in Chicago.

Student Membership — Important changes in the student membership structure of A.I.Ch.E. have been made, primarily at the suggestion of the Student Chapter Committee . . . members in good standing of a Student Chapter may on graduation become Associate Members without entrance fee; Student Member & member of a Student Chapter become practically synonymous. News of these changes was sent to all Student Chapter Counselors, & any other interested member who drops a note to headquarters will receive a complete explanation of the new requirements.

Program Note—The Program Committee is investigating the feasibility of holding one-day highly technical programs in specific fields of engineering & science. These meetings, which would be open to the membership on a first-come-first-served basis, would consist of prepared talks, notes, demonstrations, etc. It is hoped to present such programs following regular Institute meetings & to limit the subjects to specialized fields. The meetings, however, must be self-sustaining. Before the plan is put into effect, Council will review all suggestions via the Executive Committee.

F.J.V.A.

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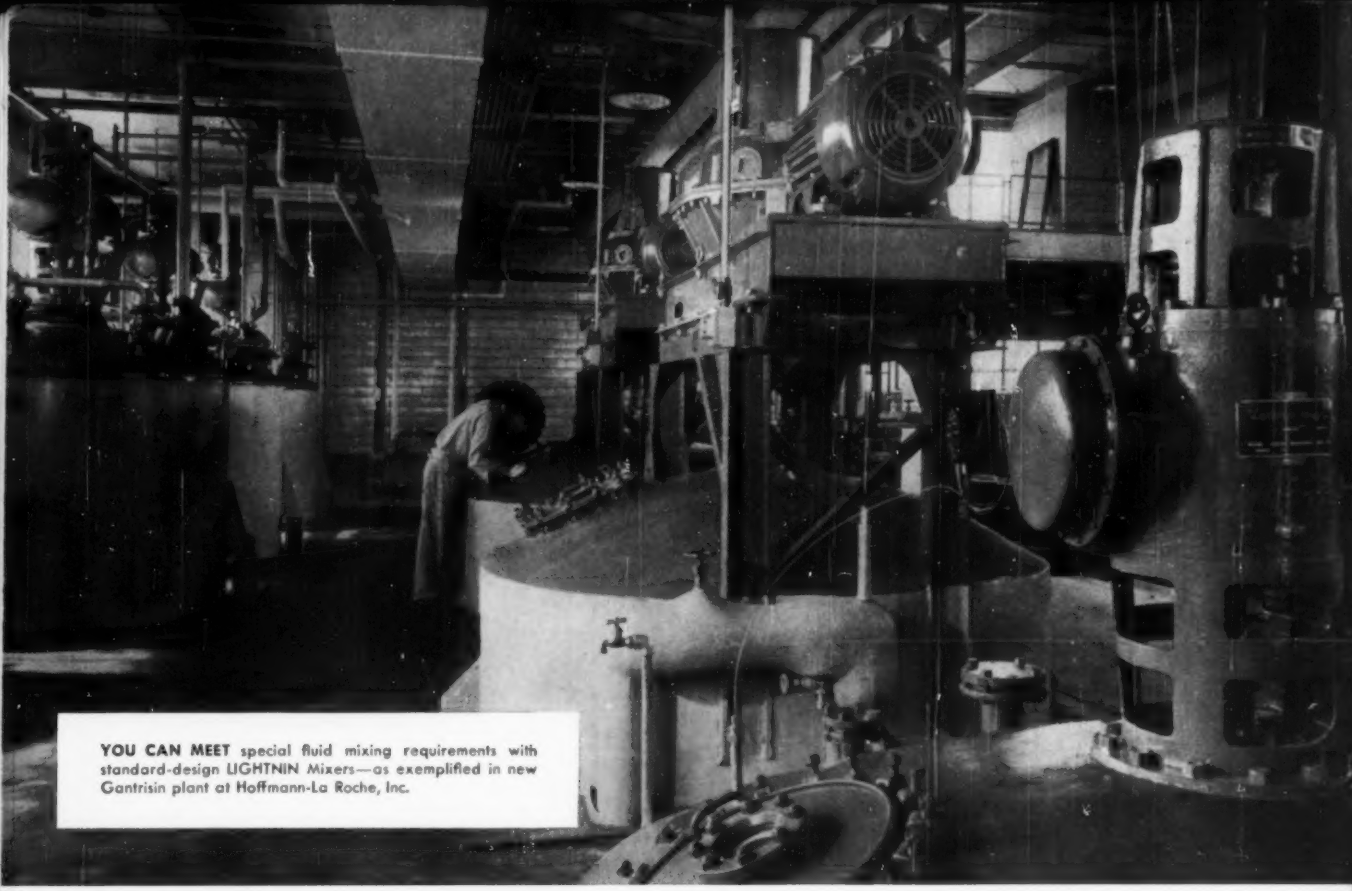

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